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A Journal of Radio Research & Progress

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VOL. XIV. No. 160

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Fred Thompson

We're awake—we only need a call!

"This," said the set manufacturer, having designed his set, planned his chassis and made his tools, "is where you put your condenser. I know it is very awkward and difficult for you. It means we shall want special shaped condensers and special fixing, but it is the only place we can spare for it."

Now, this is the view taken by some set manufacturers. As long as there is an odd corner somewhere in which the condenser can be tucked away, that seems good enough. But it is not good enough, if you want to do the job most efficiently.

Condensers play a very important part in a radio set, and if you called your condenser manufacturer (whoever he is) in to the early discussions, you would have the benefit of his viewpoint, and probably get a better job more cheaply. (Doesn't that sound reasonable—or are we just biased?)

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THE
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Vol. XIV. JANUARY, 1937. No. 160

Editorial

Electrical and Magnetic Dimensions

THE theory of dimensions, that is, the representation of physical entities in terms of a few fundamental concepts such as length, mass, and time, forms a part of the curriculum in engineering in all universities. Some branches of it have also provided a bone of contention for many years. We therefore welcome a book on the subject by Dr. Lanchester,* a leading authority on Aeronautics, who last year published a book on "Relativity; treated as a branch of Physics," which *Engineering* described as an "intellectual *tour de force*." His name on any book is a guarantee that its contents are worthy of very serious consideration, and a warning to think twice before disagreeing with them. In the Preface it is stated that the object of the book is primarily to help the young engineer to acquire a sound knowledge of dimensional theory, but, like many another book written avowedly for the young, it will be read with enjoyment and profit by many who are no longer young; in fact, the latter class of reader will be better able to appreciate the vigorous attempts to extirpate dimensional heresy—that is anything with which the author does not agree.

The greatest danger in this subject is that of overlooking the fact that, having put various ingredients into the hopper and turned the handle several times, the result has not dropped from heaven but has come out of the machine and contains all the assumptions that were put in. This is not intended to belittle the importance of the subject in any way, nor to suggest that Dr. Lanchester is not quite alive to this danger.

The book may be divided roughly into two parts, mechanical and electrical; in the mechanical part Dr. Lanchester is perfectly at home, and speaks with authority, but in the electro-magnetic sections his attitude is rather that of the explorer advancing very cautiously, seeking advice from others, and quoting their opinions without committing himself. It is refreshing to find an author who, having made a definite statement in the text, subsequently adds a footnote to say that since writing the above he has altered his mind. On p. 132 the author says: "No attempt is made in the present work to decide between one system and another; the author has endeavoured to keep an open mind."

Although only 40 pages of the book proper are devoted to electro-magnetic dimensions, the subject is referred to in several appendices, which are, however, to a large extent reprints of papers by Rücker, Fitzgerald and Sir J. B. Henderson. After devoting considerable time to a careful study of the book we are left with a feeling of dissatisfaction with the state in which the electro-magnetic branch of the subject is left, a feeling which we feel sure that we share with the author. But what can one expect when a system is built up on a basis of fiction and make-believe ?

---

* "The Theory of Dimensions and its Application for Engineers," by F. W. Lanchester, LL.D., F.R.S., pp. xxiii + 314. Crosby Lockwood, 12/6.

It is surely no exaggeration to speak in this way of the unit magnet pole of permanent magnetism and the formula $f = m_1m_2/\mu_0r^2$.

Much of the electro-magnetic portion of the book is naturally concerned with the question whether the permeability μ_0 of space is a dimensional or non-dimensional quantity.

Appendix V consists of a reprint of a paper read by Sir James B. Henderson at the British Association in September, 1935, entitled " Fundamental Dimensions in Electrical Science," the stated object of which was to show that " if, as is now generally admitted, all magnetic phenomena are in fact electro-magnetic, and Ampère's theory of molecular or atomic circuits displaces the two-fluid theory upon which our present treatment of the subject is based, there is no necessity to make an arbitrary choice of the dimensions of either μ_0 or K_0 as both are determined, and also to show that Maxwell forecast this conclusion if Ampère's theory were finally proved to be the correct one."

In the writer's opinion the paper fails in this object, the fact being that the author does make an arbitrary choice, and decides to regard μ_0 as a dimensionless numeric. It is open to anyone to decide that on grounds of convenience they will regard μ_0 as a numeric, but that is a very different thing from proving that it is so. The cause of much of the vagueness and uncertainty which has enveloped this question during the last sixty or seventy years is, as we have already said, the unreality of the formula based on a permanent magnet of unit pole strength. As Dr. Lanchester says on p. 117, " Nothing has ever been postulated by the physicist more unreal than the unit pole," but by combining this conception with permanent magnetism it loses what little reality it had and becomes a complex and ill-defined unreality. Consider the equation $f = mm'/\mu_0r^2$ which Sir James Henderson calls a " fundamental equation of the science." μ_0 is a constant of the medium, but what happens to m and m' if the two magnetic needles are immersed in another medium of different permeability ? It is meaningless to say that they remain of the same strength, because unit pole strength has only been defined in air or vacuum. What is unit pole strength in the new medium ? When two needles of unit pole strength are immersed in another medium, what is assumed to remain constant, the m.m.f. or the flux ? If forced to answer this question the champions of the unit pole will probably admit that they assume the flux to remain constant, and it is easy to show that this is really the assumption made. The arguments in this appendix are based mainly on three equations, viz. :

$$f = \frac{mm'}{\mu_0 r^2} \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

$$f = \frac{ii'\,ds\,ds'}{A'\,r^2} \quad \ldots \quad \ldots \quad (4)$$

$$f = \frac{m\,i\,ds}{Ar^2} \quad \ldots \quad \ldots \quad \ldots \quad (4a)$$

These give the forces between two poles, between two current-carrying conductors, and between a pole and a conductor. The author of the appendix comes to the conclusion that " the simplest and most obvious solution is that $A' = \mu_0 = A$" and that they are numerics ; but this is a long way from proving that it is so.

Unit Pole Solenoids

Instead of two steel needles, let us take two solenoids and pass such a current through them that they have unit pole strength. Surely no believer in Ampère's theory will quarrel with us for replacing the complex permanent magnet by a solenoid ; presumably any type of magnet could have been used to produce the unit pole—on condition, however, that it remained of unit pole strength, whatever that may have meant, when transferred to another medium.

Before making any experiments in another medium, there is an interesting experiment which is worth noting, and it is this : We can make a number of solenoids of different diameters and lengths, wound with different gauges of wire and different numbers of turns, and we can wind around the waist of each a coil of a given number of turns of fine wire connected to an instrument which indicates quantities of electricity, such as a ballistic galvanometer. We shall now make the interesting discovery that when the current in any one of the solenoids is adjusted so that it has unit pole strength—as near as one can tell according to the classical definition—a reversal of its current sends exactly the same quantity of electricity through the galvanometer. In fact, one would soon find this a more convenient way of adjusting the poles to unit strength than the historical method of putting them 1 cm away from one another and adjusting their strength until the force was one dyne. We may be told that this is all very well, but it is not the historical method; but surely a more important question for us, if we wish to get to the truth, is whether it is a fact or not.

Having adjusted two solenoids until they have unit pole strength, let us now immerse them in another medium, keeping the currents constant and the poles still 1 cm apart. We find (1) that the force between the two poles is increased from 1 dyne to μ dynes, where μ is some number obviously depending on the medium, and (2) that on reversing the current in a solenoid the quantity of electricity passing through the galvanometer is increased in the same ratio. From (1) we conclude that the forces between current-carrying conductors are proportional to this constant μ of the medium; and from (2) that whatever may be the nature of the " flux " embraced by the coil around the waist of the solenoid, it also is increased in the same ratio.

Let us now reduce the currents in both solenoids to $1/\mu$ of their initial value. We find (1) that the force between the poles is reduced from μ dynes to $1/\mu$ dyne and (2) that on reversing the current the quantity of electricity passing through the galvanometer and therefore also the " flux " has been reduced exactly to its initial value.

This is the electro-magnetic analogue of the classical imaginary permanent-magnet-unit-pole experiment. We see that the only thing which has remained of the same value in the two media is the " flux," and that the force between the two poles which have been maintained at the same " strength " is inversely as the constant μ of the medium.

If we had reduced the current in only one of the solenoids until the force between the poles was 1 dyne, leaving the other solenoid unchanged, we should have found (1) that we had reduced the current to $1/\mu$ of its former value, and (2) that on reversing the current in this solenoid the quantity of electricity passing through the galvanometer and therefore also the " flux " had been reduced to its original value. This is the basis of formula (4a) above, for we have a conductor in which we have maintained a constant current and a pole which we have maintained at constant " strength " and we find that the force between them is independent of the medium.

The Real Foundations

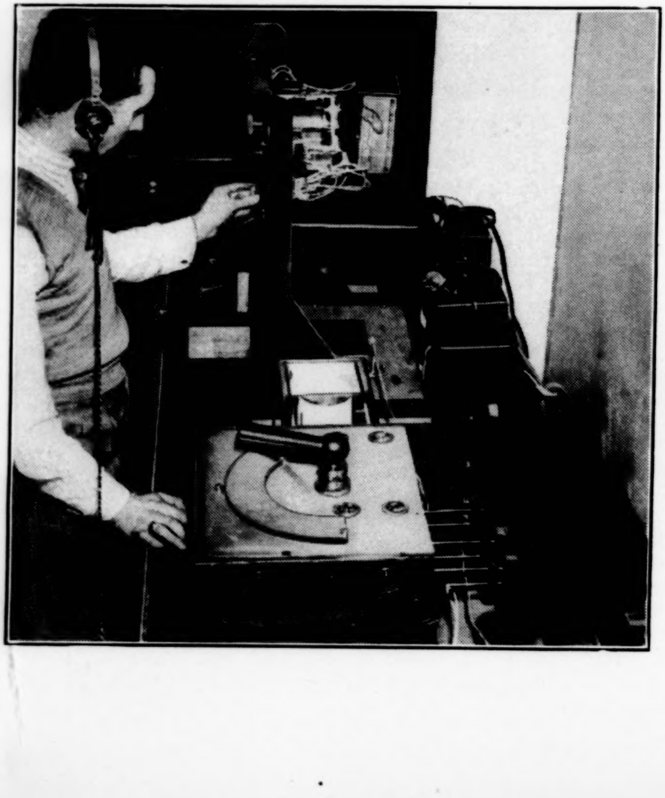
Can any believer in the modern theory of magnetism believe that when a knitting-needle of unit pole strength and a solenoid of unit pole strength are placed in a magnetic field, the former will measure one property of the field called H, whilst the latter measures another property called B? Whether the electrons are flowing in the wire of the solenoid or moving in the molecular orbits of the steel, the force on them is surely due to the same characteristic of the magnetic field, and the formula for the force between two magnet poles, $f = m_1 m_2/\mu_0 r^2$, must be merely a mysterious way of writing the formula $f = \mu_0 \frac{ids}{r^2}\, i'ds'$ for the force between current-carrying conductors. We are omitting here such things as trigonometrical coefficients and integral signs. There are then only three fundamental formulae; viz, $f = \frac{1}{\kappa_0} \cdot \frac{q}{r^2} \cdot q'$ for the force between charges at rest, the formula given above for the force between currents, i.e. charges in motion, and the connecting formula $i = dq/dt$. Although we have sought diligently we have failed to find anywhere in Dr. Lanchester's book any valid reason—beyond convenience—for assuming that either μ_0 or κ_0 is dimensionless, nor can we see what Ampère's theory of magnetism has to do with the question. In the above considerations we have assumed that the medium is space. In iron the molecular ampere-turns will give the appearance of an increased permeability, thus multiplying μ_0 by a numeric, and similarly a dielectric medium will cause K_0 to be increased. We can therefore confine our attention to space, and write

$$
\begin{array}{ll|ll}
f = \mu_0 \dfrac{i\,.\,ds}{r^2}\,.\,i\,.\,ds & & f = \dfrac{1}{\kappa_0}\,.\,\dfrac{q}{r^2}\,.\,q & \\
= \underbrace{\mu_0 H} & i\,.\,ds & = \underbrace{\dfrac{1}{\kappa_0}\,.\,4\pi D}\,.\,q & \\
= \quad B & i\,.\,ds & = \quad \mathcal{E} & q
\end{array}
$$

It should be noticed that H and D are concepts derived by calculation, the former by dividing a current by a length, the latter by dividing a charge by an area, but that the things which can be measured are not H and D but B and $\mathcal{E}$, the former by the force on a current-carrying conductor and the latter by the force on a charge. The concepts which are not directly measurable are not to be despised; they are analogous to the stress in mechanics which is the quotient of the load by the area, but which can only be measured by the strain which it produces. It may also be noted that the formula $A\,dB/dt = E = \mathcal{E}l$ involves only the concepts B, $\mathcal{E}$, and a velocity, whilst the formula $Ad(4\pi D)/dt = \text{m.m.f.} = Hl$ involves only the concepts D and H and a velocity.

There are two further points in connection with the book to which we should refer. The author discusses the pros and cons of the Giorgi system of units, but is obviously more impressed by the latter. In Appendix VII which deals with this subject, the author is rather confusing when he refers to "one Giorgi (or MKS) unit of $\mu_0 = 10^{-7}$ c.g.s. unit." The symbol μ_0 is not an abbreviation for the word "permeability" but for one definite permeability, viz. that of space, and one cannot therefore have one unit of it. On the Giorgi system a medium has unit permeability if it is 10^7 times as permeable as space, and therefore the permeability of space μ_0 is 10^{-7} Giorgi units. In Appendix VI the author seeks to apply relativity to dimensional theory and by reasoning which we cannot follow, he arrives at a strange conclusion, viz. that there are two kinds of electro-magnetic waves, one "having only magnetic characteristics" and the other "wholly static in its manifestations." We must confess that we do not believe it.

G. W. O. H.



Frequency checking apparatus, which is at present in use at the Post Office Research Station at Dollis Hill, is to be moved to Baldock, which will in future be the "ether policing" station of the Post Office. The photograph shows part of the equipment.

A New Polar Co-ordinate Cathode-Ray Oscillograph with Extremely Linear Time Scale*

By *Manfred von Ardenne*

SUMMARY.—A polar co-ordinate oscillograph with an extremely linear time scale is described, for the investigation of periodic and non-periodic processes. The circular time base is obtained by a *mixed electrostatic and magnetic* deflection system, in which the magnetic time-deflection winding forms also the inductance coil of the oscillatory circuit, whose voltage is applied to the time deflection plates. By this arrangement the need for phase balancing is avoided. Since the fluorescent circle can, by simple adjustments, be made to fall on the reference circle of a measuring scale, an exact time reading is possible. The reading error, as estimated from actual oscillograms, amounts to less than 0.5 per cent. of the rotation time; this rotation time can be varied between the limits of 1/600th sec. to 1/200,000th sec. The radial deflection is obtained by a cylindrical condenser with an adequately linear deflection characteristic. After a description of the practical design of an equipment on these lines, some typical polar oscillograms are given. In the last of these (Fig. 13) the circular time base is replaced by a *spiral time base of* 14 *turns*, giving a total base length of over 4 metres.

IN the technique of cathode-ray oscillography several methods have already been evolved for obtaining oscillograms in polar co-ordinates on the fluorescent screen. These methods will first be enumerated briefly.

They all have in common the production, on the screen, of a circular figure by means of two mutually perpendicular deflecting fields due to currents or voltages with a suitable phase difference. Such a circular time base has the advantages, over the usual time-base line produced by saw-tooth oscillations, that the ray velocity has a definite, fixed value throughout; that the oscillogram is recorded without any gaps in time; and finally that the length of the time base, for a given screen diameter, is much (π times) greater.

The deflection in the radial direction, produced by the phenomenon under investigation, is obtained (according to the methods previously known) in one of the following ways:

(1) In the earliest experiments the voltage under investigation was superposed on the anode voltage, so that deflection in a radial direction took place as a result of a modulation of the electron velocity. This method has the disadvantages that the voltages under investigation ("test voltages") have to have high values, of the same order as the anode voltage, and also that there is no linear relation between the test voltage and the radial deflection.

(2) Valve bridge circuits were developed, for the two deflection directions, to lead not only the "circle" voltage but also the "test" voltage to the deflecting systems (Goubau, *Zeitschr. f. Hochfr:tech.*, No. 1, Vol. 40, 1932, p. 1; *W.E.* Abstracts, 1932, p. 596: Watson Watt, *Applications of the Cathode-Ray Oscillograph in Radio Research*, London, 1933, p. 87: and von Ardenne, *Die Kathodenstrahlröhre*, Springer, Berlin, 1933: section on "Deflection in Polar Co-ordinates"). By such arrangements it was possible to work with comparatively small test voltages, but there was the disadvantage of the need for a very careful balance adjustment. At high frequencies the carrying out of this process presented very great difficulties, for the balancing of the bridge arms was no longer satisfactory if the "test" voltage contained several components of different frequencies.

(3) A radial deflection was abandoned and the "test" voltage was superposed on the ordinate or the abscissa plate system (Goubau and Zenneck, *Zeitschr. f. Hochfr: tech.*, No. 6, Vol. 37, 1931, p. 207; *W.E.* Abstracts, 1931, p. 432).

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* MS. accepted by the Editor, October, 1936.

The New Method

The above difficulties in obtaining a radial deflection by the phenomenon under investigation are avoided in the following method: By means of two deflecting fields of suitable relative amplitude and phase, a circular figure is produced on the screen. Between the centre of gravity of the deflecting system and the screen is arranged a cylindrical condenser, to whose electrodes the test voltage is applied.

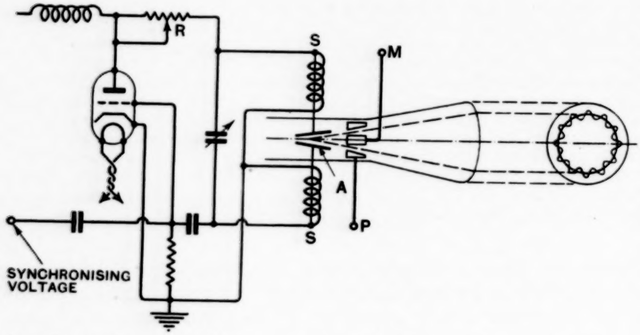


Fig. 1.—*Theoretical diagram of the Polar Co-ordinate Oscillograph.*

The production of a circular deflection presents considerable difficulty, particularly for high frequencies of rotation. Among possible methods are: (*a*) The deflecting system for the circular trace may be a double electrostatic one. In this case it is not possible, by straightforward means, to have a common centre of gravity of deflection for the two co-ordinates, so that the cylindrical condenser cannot be given a rotational symmetry and there will be an asymmetry in the test-voltage deflection system. Also, it is difficult to arrange for two deflecting voltages which will preserve, for varying frequencies, the definite phase displacement necessary for the formation of a circular trace.

(*b*) If the circular deflection is obtained by a double magnetic system, a common centre of gravity of deflection can, it is true, be obtained for the two co-ordinates, but the difficulty remains that when the rotation frequency is varied it is almost impossible to maintain the condition of correct phase and equality of amplitudes for the two co-ordinates. The actual construction, moreover, of a double magnetic system is inclined to be clumsy, and the transition from one rotational frequency to another presents difficulties.

All these troubles are overcome in a simple way by the oscillograph arrangement shown schematically in Fig. 1. Here a mixed electrostatic and magnetic system produces the circular time base: the deflecting coil *S* forms also the inductance of an oscillatory circuit whose voltage is applied to the deflecting plates *A*. By suitable adjustment of the strength of the magnetic field, *e.g.*, by altering the distance of the two coils *S* from the axis of the tube, the amplitude relation necessary for the production of a circular trace is obtained. The enormous advantage of this arrangement over the methods mentioned above is that the phase conditions necessary for circular deflection *are automatically fulfilled*, since the magnetic field of the oscillatory-circuit inductance has a permanent phase difference of 90° with respect to the voltage. With the arrangement of Fig. 1, therefore, only the equality of the amplitude of deflection along the two co-ordinates has to be looked after. The method has the further special merit of being satisfactory even at very high rotation frequencies; in addition, it is found that the amplitude conditions are comparatively little upset by alteration of the tuning of the oscillatory circuit, so that no readjustment is necessary if the frequency is only altered by a small amount.

A synchronisation of the deflection frequency can be obtained by "mitnahme" (pulling into tune), by superposing an external control voltage on the grid of the valve exciting the oscillatory circuit. For example, if the synchronising frequency is provided by a quartz-controlled generator of known fixed frequency, the rotation frequency is accurately defined and with it, for a known circle diameter, the rotational velocity of the ray motion.

The adjustment of the diameter of the fluorescent circular trace to a desired value may, for example, be carried out by the resistance R, which has no effect on the amplitude and phase relations and therefore changes the circle diameter but not its shape. This resistance simultaneously produces a linearisation of the valve characteristic of the oscillator; this action cannot be dispensed with if disturbances of the time scale by harmonics are to be avoided.

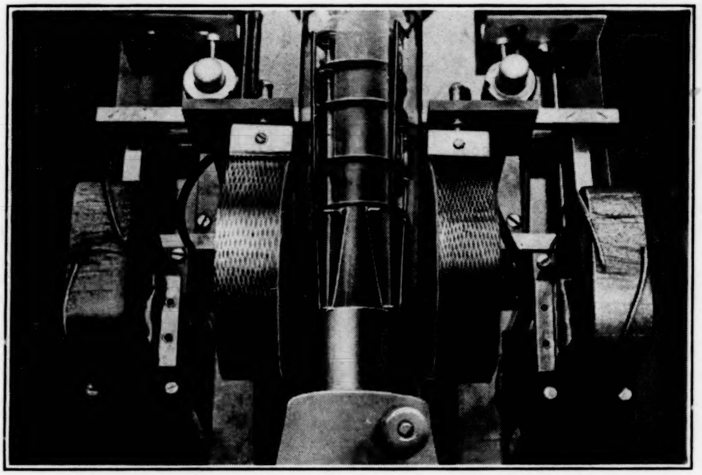


Fig. 2.—*View of the time-deflection system.*

The Time Deflection System

An accurately circular figure on the fluorescent screen can only be obtained if both the electric and magnetic deflecting fields are very uniform, and if, in addition, they are correctly adjusted with respect to one another. A practical design of the time base system, in which the deflecting coils can conveniently be adjusted owing to their sliding-carrier mounting, is shown in Fig. 2.

The important control of circularity and length of periphery is carried out by adjusting the circular trace so that it falls on a reference circle on the outside of the screen. In order that the centres of the two circles may always be brought into coincidence whatever the position of the oscillograph in the earth's magnetic field, a separate adjustment of the spot zero along each co-ordinate must be provided. The coils seen on the left and right of Fig. 2 provide a magnetic adjustment of the spot zero in the ordinate direction.

The exactness of the circular shape of the time-base trace thus obtained is seen from the oscillogram of Fig. 3: it is always readily reproducible. In order to judge the amount of error in the time scale, the oscillogram with no applied test voltage may, as mentioned above, be checked against a true circle. For the oscillogram of Fig. 3 such a check is shown in Fig. 4, where a polar co-ordinate network has been superposed on the fluorescent trace. Careful measurement of Fig. 4 shows that the largest radial errors do not exceed 2 per cent. of the radius of the reference circle. The largest possible error in the time scale will be given when the deviation from the true circle is due to a slightly elliptical course.

An exact calculation shows that the percentage error in the angular co-ordinates may reach, as a maximum, the value of the percentage radial error, but that on the average it is only about half as large as this. In the example shown in Fig. 4 this means that the relative error can at most be 2 per cent. But since, in the case of an elliptical deviation, the time points 0°, 90°, 180° and 270° must have equal time

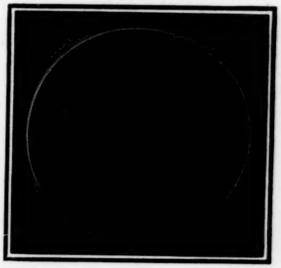
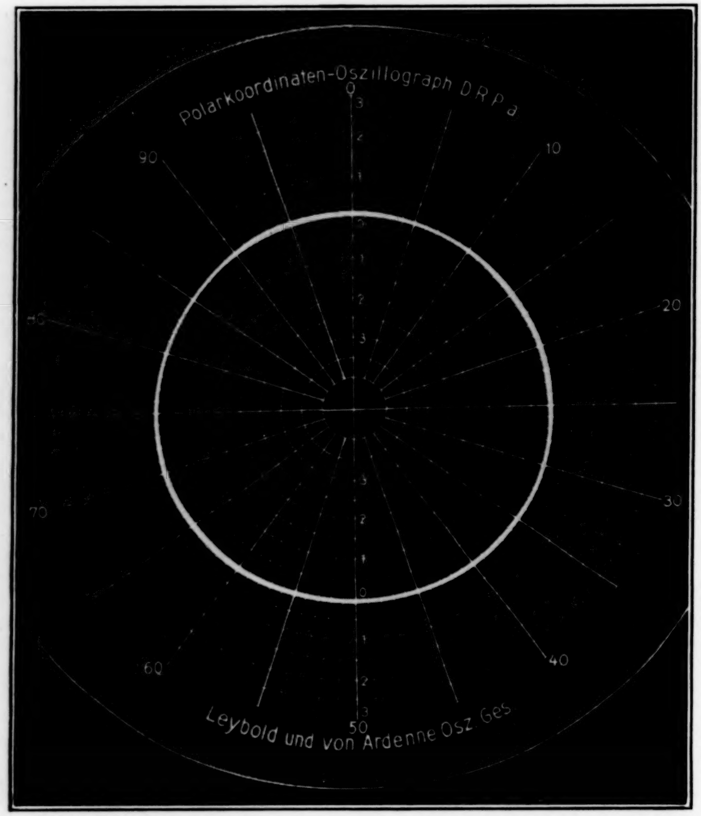


Fig. 3.—*Oscillogram of circular time base.*

intervals between them, the absolute size of the error is not proportional to the angular displacement, but after reaching a maximum for a displacement of 90° decreases once again. The absolute error in the typical case of Fig. 4 remains, therefore, under 0.5 per cent. of the time of a complete revolution.

By specially careful adjustment, the maximum possible absolute error can be reduced still further to about 0.25 per cent. of the rotation time. This accuracy of time scale, and the simplicity of control, cannot be attained in systems using relaxation oscillations for the time deflection. Any further improvement of the time scale is unnecesasry, owing to the limitations on the accuracy of reading set by the finite diameter of the spot. Assuming a spot diameter of 0.5 mm and a periphery of 300 mm, this limit is 0.15 per cent.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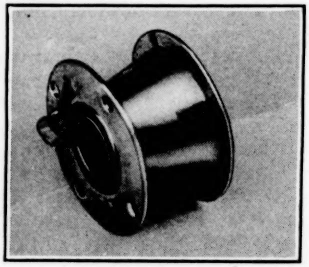
(*Above*) Fig. 4.—*Polar co-ordinate scale with "time-circle" oscillogram.*



(*Right*) Fig. 5.—*Construction of the cylindrical condenser for radial deflection.*

The accuracy of the time reading, compared with the rotation time, being thus determined, it is possible to estimate the desirable accuracy of the rotational frequency; it is sufficient if this is about 1 per cent. In practice, such a constancy can easily be obtained by synchronising the deflecting oscillator by a tuning-fork or quartz-controlled generator.

With a reasonable expenditure of oscillating power it is possible to obtain a good circular time base up to frequencies of about 200 kc/s. For a periphery of 30 cm this means a spot recording speed of about 60 km/sec. The accuracy of time measurement, assuming a 0.5 per cent. error, is 2.5×10^{-8} sec. The smallest measurable time is of the same order as this.

The lower limit of the rotation frequency is only set by dimensional considerations regarding the air-core oscillatory-circuit coils.

In the apparatus described below, frequencies down to about 600 c/s were obtained, by the introduction of suitable inductances. For special cases, where longer times have to be measured, a direct drive of the deflecting system from the 50-cycle mains can be arranged by a special connection.

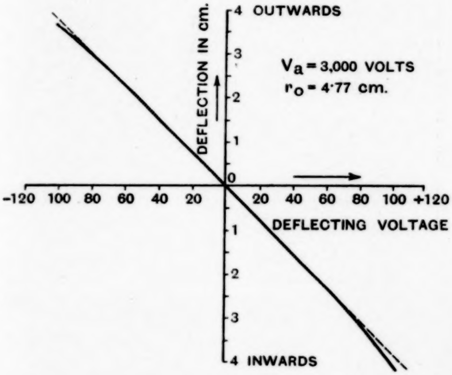


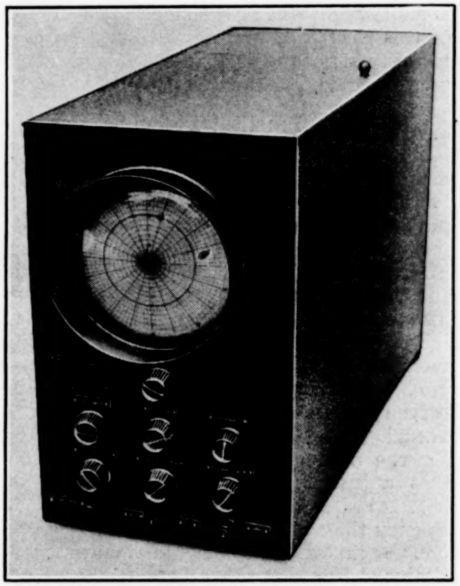
Fig. 6.—*Relation between radial deflection and the deflecting voltage.*

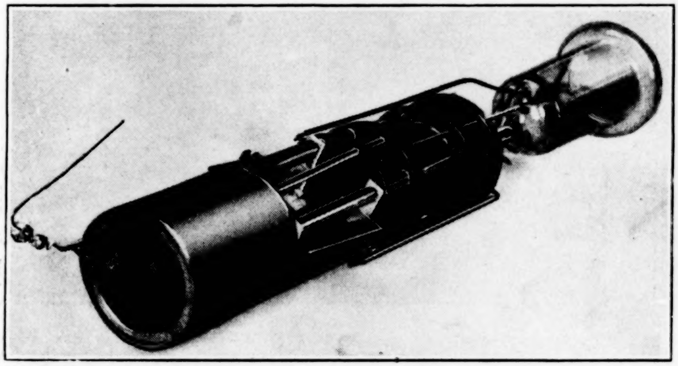
Test-Voltage Deflecting System

The practical construction of the cylindrical condenser supplying the radial deflection, and represented in Fig. 1 by the electrodes *M* and *P*, is shown in Fig. 5. Special measures taken in the fixing of the central electrode, and the construction of the lead to this electrode, ensure that with the larger ray cross-section of a high-vacuum tube no breaking-up of the oscillogram occurs and, further, that no asymmetry is produced. As can be seen from Fig. 5, the outer electrode, which is connected to the anode of the ray-generating system, is of conical shape. The inner electrode also is conical, but with a smaller angle.

Since the polar co-ordinate oscillograph is meant not only for time measurement but also for curve-form investigations, a short consideration of the linearity of the radial deflection is necessary.

As a result of the logarithmic increase of potential in a cylindrical condenser, for large deflection angles a departure of the deflection characteristic from a straight line is fundamentally to be





(*Left*) Fig. 7.—*Electrode system of the high-vacuum tube for polar co-ordinate working.*

(*Above*) Fig. 8.—*Exterior view of the Polar Co-ordinate Oscillograph with scale* (*Leybold and von Ardenne Oscillograph Company*).

feared. By a suitable choice of the diameters of the electrodes of the cylindrical condenser it is, however, possible—as the experimental curve of Fig. 6 shows—to maintain a linear relation between deflection and test voltage up to radial deflections of ± 3 cm. Since the reference circle, in the tests represented in Fig. 6, had a radius of 4.77 cm (periphery = 30 cm), a full modulation range of ± 3 cm is quite satisfactory.

The electrode system of a high-vacuum tube for recording in polar co-ordinates is shown in the photograph of Fig. 7. The inner electrode of the cylindrical condenser is led straight out at the side. The capacity of this electrode, with its lead and terminal, to that part of the system which is connected to the anode, amounts to 5.3 $\mu\mu F$.

Practical Design

Fig. 8 shows the exterior of an oscillograph based on the above principles. The adjustments are reduced to a knob for adjusting the shape of the circle, two knobs for shifting the circle in the ordinate and abscissa directions respectively, and a knob for the regulation of the circle diameter. The other knobs seen on the front of the instrument are for the coarse and fine adjustment of the rotational frequency.

A view of the interior of a fully mains-driven instrument is seen in Fig. 9. In the actual model the frequency of rotation, for the measurements now to be described, was adjusted to values between 10^3 and 2×10^4 c/s. For greater ranges of frequency the coils must be changed.

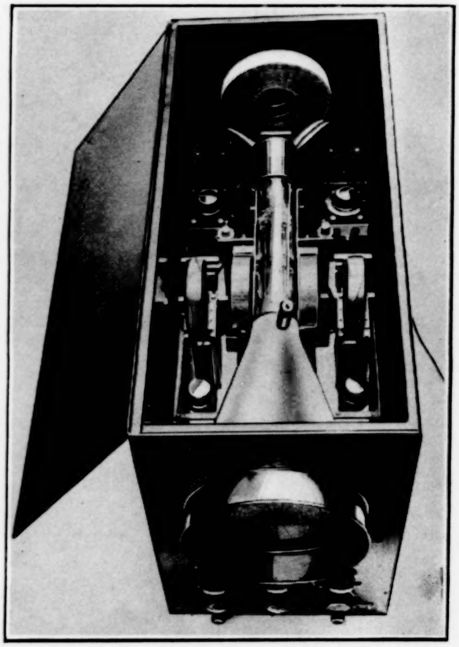


Fig. 9.—*Interior of the mains-driven oscillograph.*

The mains unit of the instrument is designed for both high-vacuum and gas-concentration types of tube; for the possibilities of the latter type are not neglected in this instrument, since the gas-concentrated tube gives a greater ray energy and consequently higher photographically recordable speeds. The great length of the time base given by this instrument allows the use of very high ray energies without any danger of scorching the screen. This property,

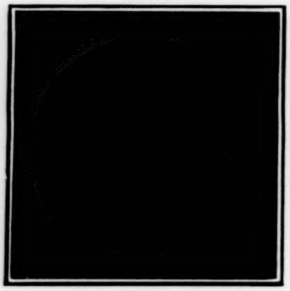


Fig. 10.—*Oscillogram of a single non-recurring process.*

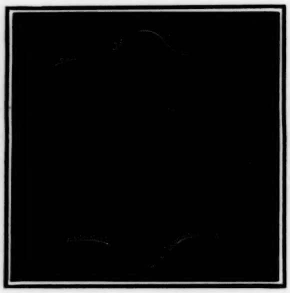


Fig. 11a.

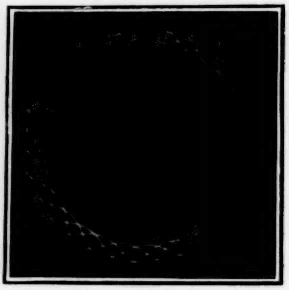
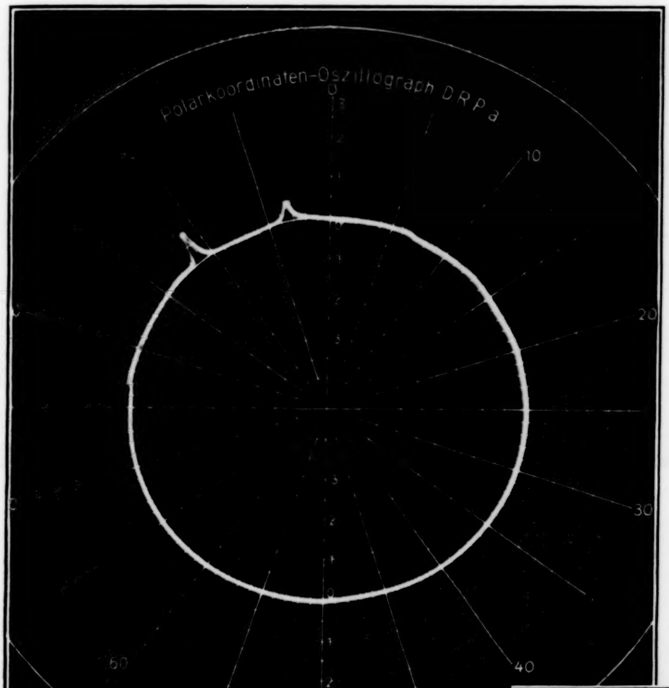


Fig. 11b.

Polar oscillograms of almost sinusoidal test voltages.

together with the linearity of the time scale and the absence of any time gaps, renders the polar co-ordinate oscillograph particularly suitable for the photographic recording of non-recurring phenomena. With the built-in mains unit and the gas-concentrated tube of the instrument illustrated in Fig. 8, and using an f : 2 lens and a photographic sensitivity of 20/10 Din, with a reduction ratio of 1 : 4 a spot-speed of 20 km/sec. is recordable. The recording may be made by an ordinary camera. If the shutter is to be kept open for a long time, it is advisable to thicken the reference circle on the scale on the outside of the fluorescent screen, so as to cover the circular fluorescent trace in order to avoid over-exposure.

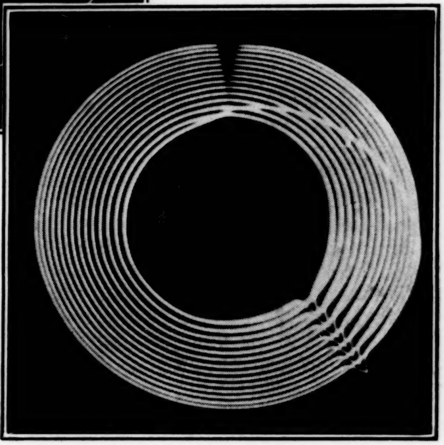


(*Left*) Fig. 12.—*Oscillogram of two impulses with an interval of* 7.6×10^{-6}; *sec. and an impulse breadth of* 10^{-6} *sec.*

Results

The oscillogram of a non-recurring process of small amplitude is shown in Fig. 10. Two polar oscillograms of approximately sinusoidal voltages are seen in Figs. 11a and 11b; the synchronisation was carried out by "mitnahme" (pulling in) of the test-voltage generator by the time-deflection generator.

The polar oscillogram of two synchronised impulses is illustrated in Fig. 12. Since the rotation frequency was in this case 10 kc/s, an interval of 7.6×10^{-6} sec. between the two impulses can be read off this record. The pulse breadth amounts to less than one-millionth



(*Below*) Fig. 13.—*Oscillogram of a "time spiral" with* 14 *turns (over* 4 *metres total length) and seven recorded impulses.*

of a second. The scale is not marked in degrees but in tens from 0 to 100, for ease in reading.

A Spiral Time Base

A particularly interesting oscillogram is shown in Fig. 13. Here the previously employed circular time base has been replaced by a " time spiral " of 14 turns, and 7 impulses are recorded. The spiral is obtained by the simultaneous superposition, on the test-voltage deflecting system, of a saw-tooth (relaxation) oscillation synchronised by the rotational frequency. For this mode of working the test-voltage electrode also is lead out separately.

The length of the time scale, which for the same screen diameter would amount only to 10 cm if produced in the ordinary way by a saw-tooth oscillator, is over 4 m in this oscillogram. As this result shows, the accuracy of measurement attainable, and the greatest stretch of time which can be covered, can be increased by a whole order of magnitude by the use of the " time spiral " in place of the " time circle." The linear time scale, given by the angular division of the instrument scale, remains, of course, unchanged when the circle is replaced by the spiral.

The Effect of Volume Compression on the Tolerable Noise Level in Electrical Communication Systems*

By E. L. E. Pawley, M.Sc.(Eng.), A.C.G.I., D.I.C., A.M.I.E.E.

IN the electrical transmission of speech or music there are always certain maximum and minimum limits of volume which may not be surpassed. In radio transmission the upper limit is the point at which the intermediate amplifiers or the transmitter itself begin to be overloaded to such an extent that the non-linear distortion introduced exceeds the permissible maximum. The lower limit of volume is fixed by the overall noise level in the transmission and reception systems and by the signal-to-noise ratio which is regarded as tolerable.

In order to estimate the value of the signal-to-noise ratio which can be tolerated it is usual, in the case of telephony, to consider the deterioration in intelligibility or in articulation caused by the noise. In broadcasting, however, this criterion is not applicable since the purpose of broadcasting is not only to convey intelligence, but also to make an æsthetic appeal to the listener. The object of the present article is to suggest an alternative method of estimating the tolerable signal-to-noise ratio in any given case and, particularly, the effect of the compression of the volume range on the signal-to-noise ratio which can be considered tolerable.

It has been shown by Professor Divoire† of the University of Brussels (Assistant Director of the Frequency-Checking Centre of the International Broadcasting Union) who has made a series of experiments on the subject, that the volume of a broadcast programme generally varies in a manner which lends itself to statistical and mathematical analysis. In fact, the instantaneous variations of volume (expressed in decibels) above and below the mean value follow with remarkable consistency a normal law of deviations. That is to say, they follow the well-known formula of Gauss :

Fraction of deviations from the mean lying between x and $x + dx$ =

$$\frac{h}{\sqrt{\pi}} \epsilon^{-h^2x^2} dx$$

where 'h' is the 'modulus of precision.' Hence the fraction of the observations lying

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* MS. accepted by the Editor, October, 1936.

† *L'Onde Electrique*, January, 1936, page 40.

between o and x is :

$$\frac{1}{\sqrt{\pi}}\int_0^x \epsilon^{-h^2x^2}\, h\, dx$$

The modulus of precision, 'h', which determines the mean variation from the mean volume, varies from one type of music to another, but for any given type of music it varies within quite narrow limits. The mean volume itself may vary from pianissimo to fortissimo in any piece of music and may also vary from one piece of music to another. It has been found that both the 'quasi-instantaneous' variations and the variations over a whole piece of music vary according to the normal law. The fact that, according to this theory, the decibel scale must be chosen for expressing the volume means that it is the subjective loudness of the programme which varies approximately in accordance with the classical law of normal probability, since the loudness is roughly proportional to the logarithm of the intensity.

An analysis of a large number of oscillograms and records taken by means of a recording peak voltmeter shows that all types of broadcast music and speech lend themselves to representation by this theory. Thus the normal probability and dispersion curves shown in Fig. 1 represent fairly closely the distribution of volumes in an ordinary broadcast programme.

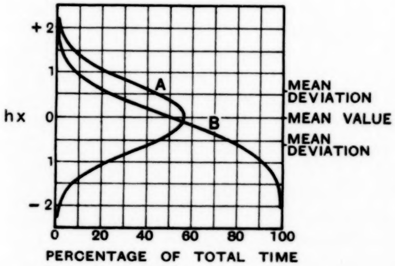

Fig. 1.

The scale of ordinates is given in terms of hx (x being in dbs.). For Curve A the percentage of total time multiplied by hdx gives the percentage of the time for which the value of hx will lie between hx and $h(x + dx)$. For Curve B the abscissae give directly the percentage of the time during which the value of hx will be attained or exceeded. By assigning a value to 'h' corresponding to the dynamic range of the programme, the scale can be converted into decibels for any dynamic range. This has been done in Fig. 2, which shows corresponding dispersion curves for various dynamic ranges, that is various values of 'h.' It may be noted in passing that the R.M.S. deviation is given in each case by :

$$\sigma = \frac{1}{\sqrt{2}\,h} \quad \text{or } h\,\sigma = \frac{1}{\sqrt{2}}$$

and the mean deviation by :

$$m = \frac{\sigma}{\sqrt{\frac{\pi}{2}}} \quad \text{or } hm = \frac{1}{\sqrt{\pi}}$$

It will be seen from Fig. 1, Curve B, that for about 21 per cent. of the total time the deviations above the mean value exceed the mean deviation and that for about 79 per cent of the total time the instantaneous value is greater than that corresponding to the mean of the deviations below the mean value. The instantaneous value exceeds the mean value for 50 per cent. of the time, *i.e.*, the mean value is equal to the median value.

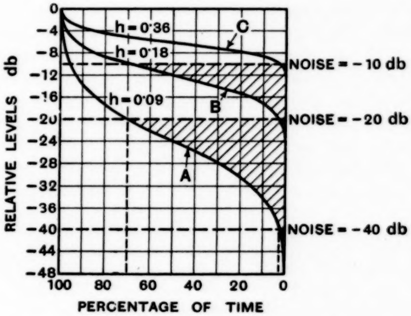

Fig. 2.

For some purposes Professor Divoire has found it convenient to speak of quasi-maximum and quasi-minimum values, which are defined as the values which are exceeded for 5 per cent. and 95 per cent. of the time, respectively. The absolute maximum and minimum values, according to the theory, are plus and minus infinity respectively, but in practice there are obvious limits to the actual maximum and minimum values, even of the original performance, the former being fixed by the maximum sound output of the musical instruments and the latter by the level of room-noise and by the reverberation in the studio. The maximum and minimum values which are effective in practice are equal to the theoretical values corresponding to about 0.1 per cent. and 99.9 per cent. of the total time, respectively.

Armed with the theoretical dispersion curve of Fig. 1 B, we can determine the percentage of the total time for which a given programme will be masked by background noise of any specified intensity. For instance, if the total effective range of volume variation (dynamic range) is 48 db., as it may be for an orchestral work the range of which has not been artificially compressed, then the dispersion can be represented by Fig. 2, Curve A. The range between quasi-maximum and quasi-minimum is here about 26 db. Now if the total noise heard at the receiver covers the whole frequency spectrum uniformly and if it has a steady value 40 db. below the effective peak volume of the programme, it will mask the programme for about 2.5 per cent. of the total time. Heavier noise 20 db. below the effective programme peaks will mask the programme for 70 per cent. of the total time.

But if, before transmission, we compress the programme linearly (on the decibel scale) to an effective range of 24 db., either manually or automatically, but keeping the effective maximum value the same as before, we achieve the condition shown by Fig. 2, Curve B. Here it is evident that background noise amounting to 40 db. below the programme peaks will not mask the programme at all, while noise 20 db. below will mask the programme for only 2.5 per cent. of the time. A high received noise level, such as may be experienced in short-wave reception at long distances, may be only 10 db. below the programme peaks. In this case compression to an effective range of 24 db. would still mean that the programme would be masked by noise for 70 per cent. of the time and would, therefore, be æsthetically worthless even if it were partially intelligible. Further compression to an effective range of only 12 db., as shown in Curve C, would, however, again reduce the loss of programme time to 2.5 per cent. which might be considered tolerable.

These principles may be applied to assessing the effect, not only of radio-interference such as atmospherics, but also of noise originating in lines, recording systems or amplifiers. Interference from these sources is, however, generally less important than the noise inherent in the radio transmission channel. Noises introduced in the low-frequency channel are not always uniformly distributed over the frequency spectrum and a weighting factor must, therefore, be applied to estimate their effect on the ear.

If the background noise is not steady, but varies irregularly with time, it may happen that the noise attains a maximum at the same time as the programme is at a minimum, but this will obviously not happen so often as if the noise remained steadily at its maximum value. The combined probability can be easily determined by multiplication. For instance, if the background noise attains a value 10 db. below the peaks of the programme represented by Fig. 2, Curve B, for 10 per cent. of the total time and is negligible for the rest of the time, the programme will probably be masked for only 10 per cent. × 70 per cent. = 7 per cent. of the time. If the interference varies according to the same law of probability as the programme, the combined probability can readily be determined.

In interpreting these results so as to estimate the degree of volume compression which is desirable on a programme channel with a given value of background noise, it must be remembered that the overall range of volume includes slow variations in mean volume in addition to rapid variations about the mean and that the range of instantaneous volumes considerably exceeds the range indicated by a comparatively slowly moving meter of the "volume-indicator" type.

The author is indebted to the Chief Engineer of the British Broadcasting Corporation for permission to publish this paper.

Distortion Produced by Delayed Diode A.V.C.[*]

By K. R. Sturley, Ph.D., A.M.I.E.E.

SUMMARY.—Distortion of a modulated R.F. voltage is produced under certain conditions in the anode circuit of an amplifier containing a diode supplying bias for volume control.

The case of a diode with a resistance shunted across it is treated first and distortion of the modulation is shown to exist between the carrier voltage limits $\hat{E}_1 = \frac{V_d}{(1 + M)}$ to $\hat{E}_3 = \frac{V_d}{(1 - M)}$ where V_d is the delay voltage in series with the diode and M the modulation percentage. No distortion is produced when the delay voltage is zero. Maximum distortion for normal shunt resistance values occurs when $\hat{E}_2 = V_d$, and its value is dependent on the impedance in the anode circuit and the resistance shunted across the diode, but is independent of the modulation percentage.

Certain modifications are introduced when the diode has a resistance capacity filter in addition shunted across it, and the conditions of distortion are from $\hat{E}_1 = \frac{V_d}{(1 + M)}$ to $\hat{E}_3 = \frac{V_d}{\left[1 - M \, . \, \frac{R_{DC}}{R_{AC}}\right]}$ where R_{DC} is the resistance to DC, and R_{AC} the resistance to AC shunted across the diode. Maximum distortion is produced when $\hat{E}_2 = \frac{V_d}{\left\{1 - \frac{M}{\pi}\left[\frac{R_{DC}}{R_{AC}} - 1\right]\right\}}$. When the delay voltage is zero distortion is only introduced when $\frac{R_{AC}}{R_{DC}} < M$ and its value will be independent of carrier voltage.

It is shown that a diode having a resistance of R_{DC}' shunted across it will have the same value of maximum distortion as a diode with an equivalent A.C. resistance ($R_{DC}' = R_{AC}$) shunted across it.

During investigation of the distortion[†] produced in a superheterodyne receiver fitted with delayed diode A.V.C., it was noted that the total harmonic distortion in the L.F. output reached a maximum at a particular R.F. input voltage. The source of this distortion proved to be the delayed diode supplying the A.V.C. bias and the effect of this valve was determined in a series of tests with the following operating conditions:

(1) Variable delay voltage with two values of percentage modulation.

(2) Variable percentage modulation with fixed delay voltage.

(3) Variable diode D.C. shunt resistance with fixed delay voltage and percentage modulation.

(4) Variable A.C. shunt resistance with fixed D.C. shunt resistance, delay voltage and percentage modulation. This corresponds to the operating conditions of the A.V.C. diode with an H.F. filter supplying bias to the R.F. valves.

(5) Variable coil impedance with conditions as for (3) with fixed D.C. shunt resistance.

Theory

A typical circuit for obtaining A.V.C. bias is shown in Fig. 1*a*. Valve V_1 is a radio frequency amplifier of the pentode type with a tuned transformer in its anode circuit. The A.V.C. diode is coupled to the anode by means of a condenser C_1 and a resistance R_D provides a return path for the D.C. component of the diode current. The delay voltage is inserted in the cathode circuit of the diode. A filter is necessary so that the D.C. component only is applied to the controlled valves, and it will usually take the form of a resistance R_F and capacity C_2 as shown. Since rectification of the modulation envelope occurs when a modulated signal is applied, the value of C_2 must be such that efficient filtering is obtained at the lowest modulating frequency, and it will therefore be assumed that the equivalent shunt circuit for alternating currents is represented by R_F and R_D in parallel. Reference in the paper to the diode D.C. and A.C. shunt resistances should be taken to imply R_D and $\dfrac{R_D \, . \, R_F}{R_D + R_F}$ respectively.

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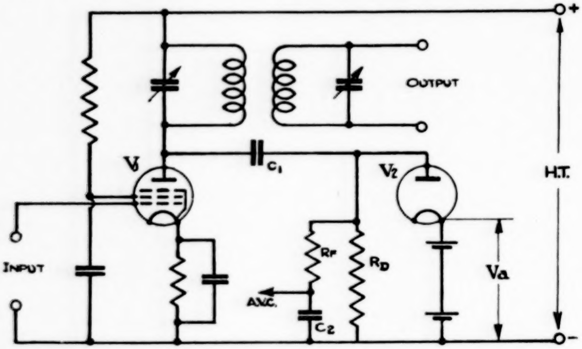
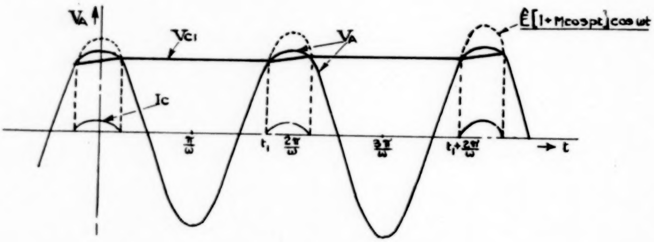
[*] MS. accepted by the Editor, January, 1936.

[†] Since the compilation of this paper the author has noted a reference to this effect in a paper by W. J. Brown, to the *I.E.E.*, "The Design of a High-Fidelity Radio Gramophone." *J.I.E.E.*, (Wireless Section), Vol. 11, No. 31.



(Above) Fig. 1a.

(Right) Fig. 1b.



The modifications introduced by the A.V.C. diode in the output operating conditions of the R.F. amplifier can be indicated on the typical $I_a V_a$ curves shown in Fig. 2(a).

The case of a diode without a resistance capacity filter will first be considered and certain assumptions made.

1. An undistorted modulated signal $\hat{E}_g[1 + M \cos pt] \cos \omega t$ is applied to the grid of the R.F. amplifier which is operating without distortion over the range of grid voltages considered.
2. The tuned transformer in the anode circuit is a constant resistive impedance over a frequency range covered by the signal and its side bands, and its impedance is zero at all other frequencies.
3. The A.V.C. diode has linear rectification characteristics for all applied voltages and the capacity from anode to cathode is zero.
4. The coupling condenser C_1 (Fig. 1a) has a value which allows practically the full R.F. voltage to be applied to the diode, but is not large enough to cause distortion of the rectified modulation envelope.[1]
5. The diode begins to conduct only at the extreme positive peaks at time instants separated by $\frac{2\pi}{\omega}$ and change of amplitude does not affect these time instants (Fig. 1b). It should be noted that the value of the D.C. shunt resistance (R_D) controls the start of the charge period and decrease of this resistance decreases t_1 and increases the maximum value of the pulse of charging current through the condenser C_1.
6. The diode has a delay voltage equal to V_d.

If the point O on the $I_a V_a$ curves in Fig. 2a is the quiescent condition for the R.F. amplifier, the tuned transformer impedance may be represented by a straight line such as AB. The anode voltage corresponding to the diode delay voltage is given by the point V_1 where $(V_1 - V_0) = V_d$ and the diode can only influence the output circuit conditions when the anode voltage exceeds V_1.

Current will be taken from the anode circuit to charge condenser C_1 as soon as the diode conducts. This can be illustrated by the two curves EF and FG*, where EF represents the condition of rising and FG that of falling anode voltage. Decrease of the D.C. shunt resistance R_D causes the curve EF to move towards C to $E'F'$ and increase in length, so that F' falls on the same grid voltage line as F. The load characteristic for an unmodulated signal $\hat{E}\cos\omega t$ will therefore consist of the four lines AE, EF, FG and GA, and this will produce an output voltage wave of sinusoidal shape except for the extreme positive peak which will be attenuated by the diode damping. Such a shape is shown in Appendix 1 to be represented by

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[1] *See* Bibliography.

* *See* Appendix 1.

$$\hat{E}[\cos\omega t - (C_0 + C_1\cos(\omega t + \phi_1) + C_2\cos(2\omega t + \phi_2) + \ldots\ldots)]$$

The effect of the A.V.C. diode is therefore to cause distortion† of an unmodulated R.F. signal when the signal peak voltage exceeds the delay voltage. From assumption 2 it will be seen that voltage transferred to the secondary of the tuned transformer will not be distorted, but will be reduced in amplitude to $\hat{E}[\cos\omega t - C_1\cos(\omega t + \phi_1)]$.

For a modulated R.F. voltage $\hat{E}(1 + M\cos pt)\cos\omega t$, the output circuit conditions will be represented by drawing a series of parallel diode load curves from their appropriate positions from AB as in Fig. 2*b*. It follows from assumption 5 that the locus of the extremities of these load lines will form a straight line CD intersecting AB at C, the anode voltage corresponding to the diode delay voltage. The anode load characteristic to the modulation envelope will now consist of two lines AC and CD and distortion of the R.F. carrier voltage will always be produced when the anode voltage exceeds V_1. This does not necessarily mean that distortion of the modulation envelope will result, and damping from the diode will have two effects as shown in Figs. 3*a* and 3*b*.

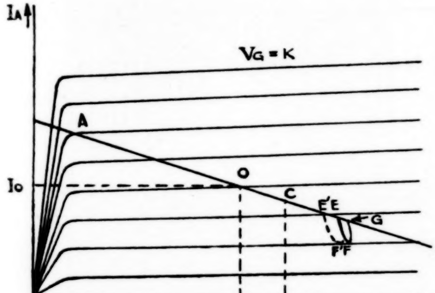

Fig. 2a.

In Fig. 3*a* the diode delay voltage is less than the minimum modulated carrier voltage $\hat{E}(1 - M)$ and the whole of the positive modulation envelope is consequently reduced in amplitude to $\hat{E}M_0\cos pt$. The value of M_0 will depend on the angle between AC and CD and will be given by the expression

$$M_0 = M \cdot \frac{\cos\widehat{BCV_1}}{\cos\widehat{DCV_1}}$$

This modulated wave with unequal negative and positive modulation envelopes can be analysed into its components by a method similar to that employed for the damped

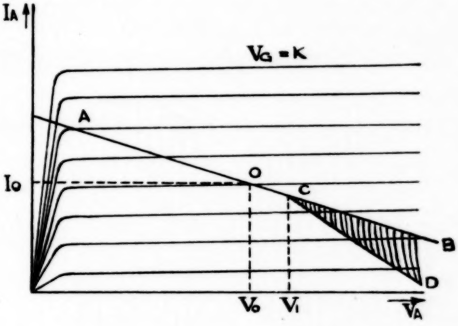

Fig. 2b.

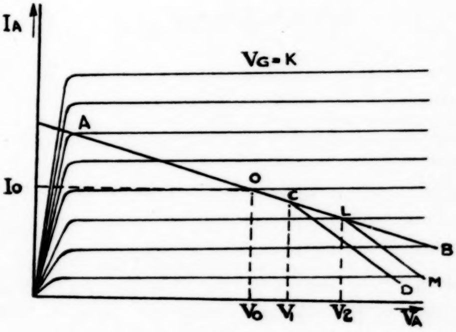

Fig. 2c.

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† Owing to rectification of the anode voltage the value of I_0 will be increased raising the line AB. The effect is small and is neglected.

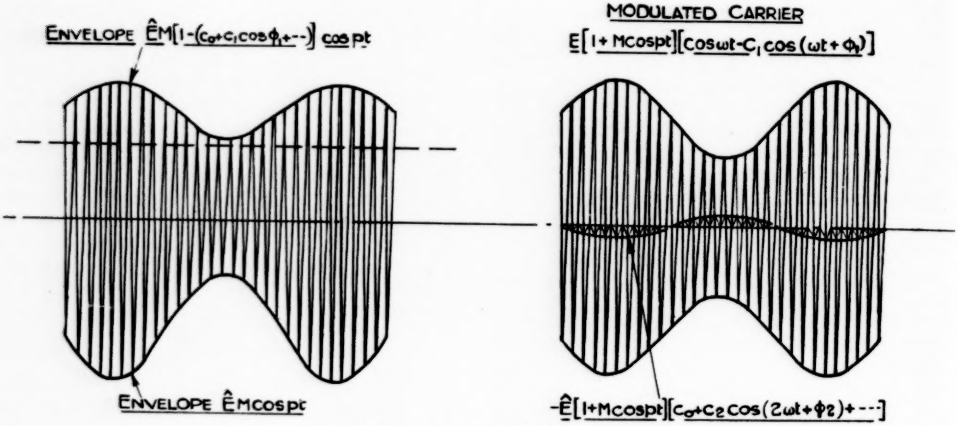
ENVELOPE ÊM[1-(C₀+C₁cosφ₁+--)] cos pt
MODULATED CARRIER
Ê[1+Mcospt][cosωt-C₁cos(ωt+φ₁)]
ENVELOPE ÊMcospt
-Ê[1+Mcospt][C₀+C₂cos(2ωt+φ₂)+---]

Fig. 3a.—$\hat{E}\,(I - M) > V_d$.

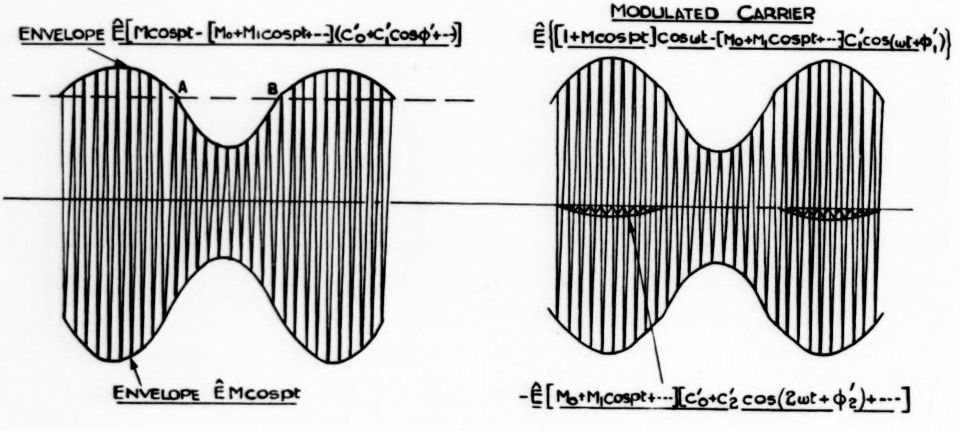
ENVELOPE Ê[Mcospt-[M₀+M₁cospt+--](C′₀+C′₁cosφ′+--)]
A
B
MODULATED CARRIER
Ê{[1+Mcospt]cosωt-[M₀+M₁cospt+--]C′₁cos(ωt+φ′₁)}
ENVELOPE ÊMcospt
-Ê[M₀+M₁cospt+---][C′₀+C′₂cos(2ωt+φ′₂)+---]

Fig. 3b.—$\hat{E}\,(I - M) < V_d$.
Anode Voltage Waveform.

unmodulated wave and the resulting expression is

$$\begin{aligned}&\hat{E}[1 + M\cos pt]\cos\omega t\\&\quad - \hat{E}[1 + M\cos pt][C_0 + C_1\cos(\omega t + \phi_1)\\&\quad + C_2\cos(2\omega t + \phi_2) + \ldots\ldots]\end{aligned}$$

where the coefficients C_0, C_1; etc., are such as to make the expression

$$(C_0 + C_1\cos(\omega t + \phi_1) + C_2\cos(2\omega t + \phi_2) + \ldots)$$

zero for values of "ωt" between $\frac{\pi}{2}$ and $\frac{3\pi}{2}$, thus giving a negative modulation envelope of $\hat{E}M\cos pt$. and a positive modulation envelope† of

$$\begin{aligned}\hat{E}M[1 - (C_0 + C_1\cos\phi_1\\ + C_2\cos\phi_2 + \ldots)]\cos pt.\end{aligned}$$

Since the anode impedance is assumed to be zero at frequencies other than those of the carrier and side bands, the resultant voltage transferred to the secondary will be

$$\hat{E}[1 + M\cos pt][\cos\omega t - C_1\cos(\omega t + \phi_1)]$$

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† The positive modulation envelope is obtained by putting "ωt" equal to "$2n\pi$."

which is an undistorted modulated carrier of reduced amplitude.

It will therefore be seen that if the modulation envelope does not sweep over the junction of the two load lines AC and CD, an undistorted modulated signal will be transferred to the secondary of the anode transformer. Thus $\hat{E}(1 - M) > V_d$ is a condition of no modulation distortion and $\hat{E}(1 + M) < V_d$ will obviously be another.

In Fig. 3*b* the diode delay voltage is greater than the minimum modulated carrier voltage $\hat{E}(1 - M)$, so that the modulation envelope sweeps over the junction of the two load lines AC and CD. When the modulated carrier voltage is less than the delay voltage no attenuation takes place, so that the modulation wave will follow a cosine wave of the normal amplitude, but when the delay voltage is exceeded it will follow a cosine wave of smaller amplitude. Analysis* of this modulation envelope shows that it contains fundamental and harmonic components of the modulation frequency and the resulting modulated RF voltage is represented by

$$\hat{E}[1 + M \cos pt]\cos \omega t - \hat{E}[M_0 + M_1 \cos pt + M_2 \cos 2pt + \ldots][C_0' + C_1' \cos(\omega t + \phi_1') + C_2' \cos(2\,\omega t + \phi_2') + \ldots]$$

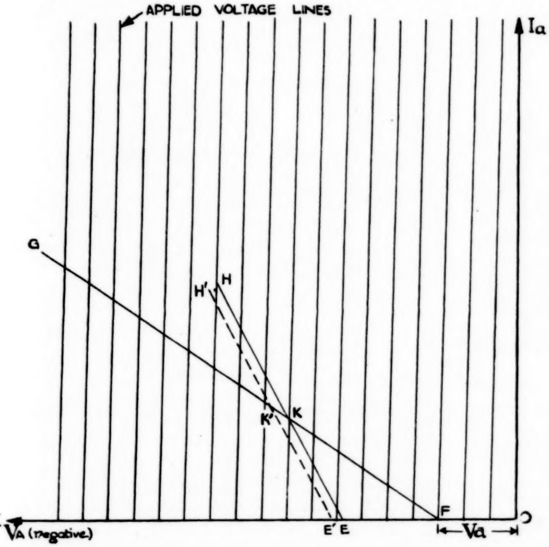

Fig. 4.—*Anode current—Anode voltage curves of diode of linear characteristics.*

D.C. shunt resistance $= R_D = \cot \widehat{GFX}$.

A.C. shunt resistance $= \dfrac{R_D \cdot R_F}{R_D + R_F}$

$= \cot \widehat{HEX}$.

The coefficients C_0', C_1', etc., make the expression $(C_0' + C_1' \cos(\omega t + \phi_1') + \ldots)$ zero for values of "ωt" between $\frac{\pi}{2}$ and $\frac{3\pi}{2}$ and the coefficients M_0, M_1, etc., make the expression

$$(M_0 + M_1 \cos pt + M_2 \cos 2pt + \ldots .)$$

zero during the period from A to B in Fig. 3*b*.

A modulated carrier voltage

$$\hat{E}[[1 + M \cos pt]\cos \omega t - [M_0 + M_1 \cos pt + M_2 \cos 2pt + \ldots][C_1' \cos(\omega t + \phi_1')]]$$

having a distorted modulation envelope will be transferred to the secondary of the tuned transformer. Appendix 2 shows that if the diode damping is not excessive this distortion will reach a maximum when half the modulation envelope is reduced in amplitude, *i.e.*, when the peak carrier voltage equals the delay voltage. The modulated carrier voltage will then be represented by

$$\hat{E}[(1 + M \cos pt)\cos \omega t - M(a_0 + a_1 \cos pt + a_2 \cos 2pt + \ldots)\, C_1' \cos(\omega t + \phi_1')]$$

and increase in percentage modulation will not affect the maximum distortion. The value of the modulation percentage will affect the region of carrier voltages over which distortion will be introduced. The limits of this region are given by

$$\hat{E}_1 = \frac{V_d}{1 + M} \text{ to } \hat{E}_3 = \frac{V_d}{1 - M}$$

It will be evident that the reduction in amplitude of part of the modulation envelope will depend on the ratio of transformer impedance to diode D.C. shunt resistance (R_D in Fig. 1*a*) that is the angle between the load lines AC and CD (Fig. 2*b*). With a low transformer impedance and high value of the R_D angle ACD will be very nearly 180°, so that the reduction in amplitude of part of the modulation envelope will be small, and consequently little distortion will be introduced.

---

* Appendix 2.

It is necessary now to consider an A.V.C. diode supplying bias through a resistance capacity filter. This filter will constitute an extra A.C. load and its effect on the operating conditions is illustrated on the diode $I_a V_a$ curves in Fig. 4.

OF is the delay voltage and *FG* the D.C. load line.

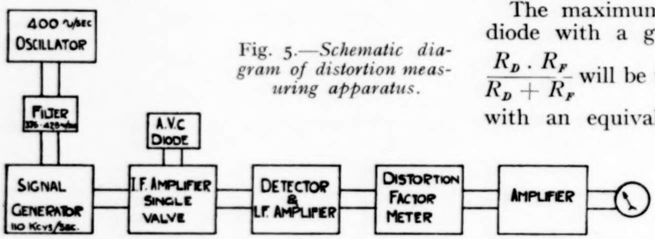

Fig. 5.—*Schematic diagram of distortion measuring apparatus.*

If *K* is the operating point for a given carrier voltage the A.C. load line[2] will be *HKE* where

$$\tan HEX = \frac{R_D + R_F}{R_D \, . \, R_F}.$$

It is important to note that the point *K* will cut a carrier voltage line at a value higher than the actual carrier voltage if the modulation envelope falls below *E*, *i.e.*, is rectified. The A.C. load line will take a new position such as *H'K'E'*. The load from the diode will therefore be increased by the addition of the filter from R_D to $\frac{R_D \, . \, R_F}{R_D + R_F}$ and the effective delay voltage will be *OE'*. These conditions can be represented by a line such as *LM* on the amplifier $I_a V_a$ curves (Fig. 2*c*) and the point *L* will not be fixed, but travel farther from *O* as the carrier voltage is increased.

Thus the diode will show the same operating characteristics as a diode with a D.C. shunt resistance R'_D equal in value to the A.C. shunt resistance $\frac{R_D \, . \, R_F}{R_D + R_F}$, except that the delay voltage is not fixed, but increases as the carrier voltage is increased. Distortion will be introduced as soon as the maximum modulated carrier amplitude $\hat{E}(1 + M)$ equals the delay voltage, and will reach a maximum when the peak carrier voltage equals the effective delay voltage, $V_2 - V_0$ in Fig. 2*c*, the value of which depends on the rectified modulation current —increase of modulation percentage increases the rectified current—and the A.C. shunt resistance. Increase of either will cause the line *H'K'E'* to move farther from *HKE*, thus increasing the effective delay voltage *OE'* and the carrier voltage required to give maximum distortion.

The maximum value of distortion for a diode with a given A.C. shunt resistance $\frac{R_D \, . \, R_F}{R_D + R_F}$ will be the same as that for a diode with an equivalent D.C. shunt resistance $\left(R_D' = \frac{R_D \, . \, R_F}{R_D + R_F}\right)$ since the angles *ALM* and *ACD* (Fig. 2) will be equal, but the peak carrier voltage required to reach this point will be larger, since the delay voltage is no longer the D.C. voltage in series with the diode.

Zero distortion will be reached when the minimum modulated carrier voltage $\hat{E}(1 - M)$ is greater than $(V_2 - V_0)$. The value of the carrier voltage required to attain this condition will depend on the A.C load resistance and the percentage modulation. With a large percentage modulation there may never be a position of zero distortion.

This condition is realised when *M* is greater than $\frac{R_{AC}}{R_{DC}}$.

Apparatus

A schematic diagram of the apparatus is indicated in Fig. 5.

The output from a standard signal generator capable of modulation to 80% with low distortion was supplied to the grid of the I.F. amplifier valve,† biased for minimum distortion. In the anode circuit was a tuned I.F. transformer. The A.V.C. diode* was connected in the conventional way across the primary. Provision was made for changing the delay voltage, diode D.C. shunt resistance and H.F. filter resistance. The H.F. filter condenser had a value of 0.1 μF. The secondary of the transformer was connected to a detector diode and L.F. amplifier. A distortion factor meter was connected to the output of the latter and measured the percentage total harmonic distortion produced in the modulation. The meter measured the R.M.S. value of total distortion, and as the phase relationship between this distortion and that from the A.V.C. diode was unknown the experimental results give the R.M.S. value of both distortions.

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[2] *See* Bibliography.

† Mazda Valve Type AC/VP1.

* Mazda Valve Type V914.

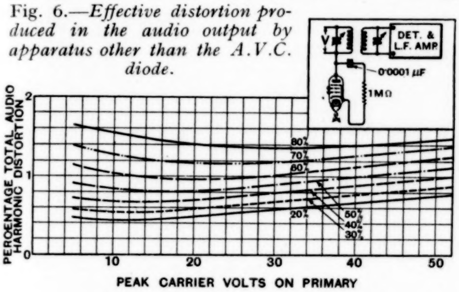


Fig. 6.—*Effective distortion produced in the audio output by apparatus other than the A.V.C. diode.*

A carrier frequency of 110 kcys/sec., modulated at 400 cycles/sec. was employed and the distortion produced in the apparatus other than the A.V.C. diode is indicated in Fig. 6. The anode impedance was 100,000 ohms.

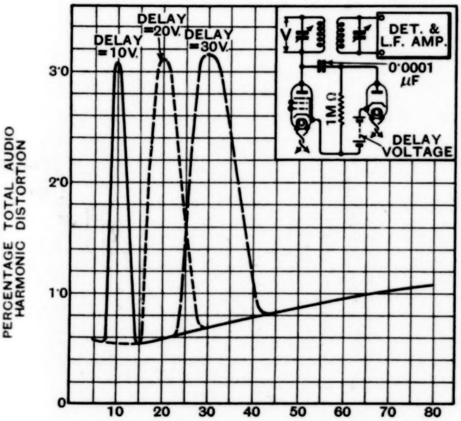


Fig. 7a.—*Effective distortion produced in the audio output by the A.V.C. diode with different delay voltages. 30% modulation of carrier.*

Experimental Results

1. *Variable Delay Voltage.*

The effect of delay voltage is indicated for 30% and 60% modulation in Figs. 7*a* and *b*. Distortion from the A.V.C. diode:

a. Was introduced at a peak carrier voltage E_1 where $\hat{E}_1(1 + M) = V_d$ (delay voltage).

b. Reached a maximum when $\hat{E}_2 = V_d$.

c. Fell to zero when $\hat{E}_3(1 - M) = V_d$.

At higher delay voltages the maximum distortion increased slightly owing to the rise in distortion in the associated apparatus.

Since the distortion is due to a damping of part of the positive modulation envelope, its value should be dependent for given A.V.C. diode conditions only on the proportion of the modulation envelope damped. For a fixed modulation percentage the ratio $\dfrac{\text{peak carrier voltage}}{\text{delay voltage}}$ is a measure of the proportion of modulation envelope damped. Hence by plotting the distortion from Fig. 7*a* against the ratio $\dfrac{\hat{E}}{V_d}$ as in Fig. 8 the

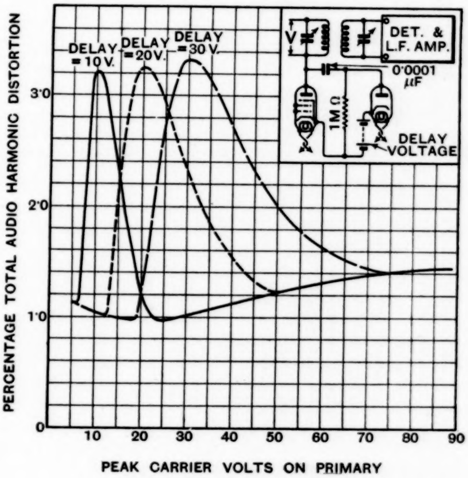


Fig. 7b.—*Effective distortion produced in the audio output by the A.V.C. diode with different delay voltages. 60% modulation of carrier.*

curves for different delay voltages were almost identical.

If distortion is plotted against the proportion of envelope damped, *i.e.*, the ratio

$$\frac{\hat{E}(1 + M) - V \text{ delay}}{2\hat{E}M}$$

the curves from Figs. 7*a* and 7*b* should be identical. Fig. 9 shows the curves for 30% and 60% modulation and a delay voltage of 20 plotted in this manner.

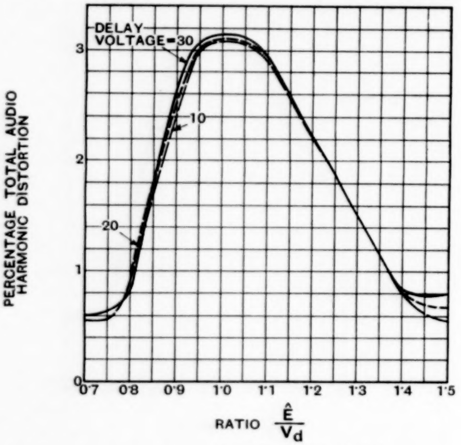


Fig. 8.—*Distortion—ratio* $\frac{\textit{peak carrier voltage}}{\textit{delay voltage}}$ *curves. 30% modulation. Delay voltages* = 10, 20 & 30 V.

2. *Fixed Delay Voltage.*

Maximum distortion (Fig. 10) increased slightly as the percentage modulation was increased, due to the rise in distortion in the associated apparatus.

The range of carrier voltage over which the A.V.C. diode introduced distortion was from $\hat{E}_1$ to $\hat{E}_3$ where

$$\hat{E}_1(1 + M) = V_d = \hat{E}_3(1 - M)$$

3. *Variable Diode Shunt Resistance.*

The curves in Fig. 11 show that decrease of diode shunt resistance raised the distortion, but did not affect the carrier voltage distortion range. It is important to note that under the particular test conditions decrease of this resistance changed the slope of line *AC* (Fig. 2) as well as that of *CD*.

4. *Variable A.C. Shunt Resistance.*

The distortion from a diode operating under normal A.V.C. conditions is summarised by the curves in Figs. 12*a* and *b*. It will be noted that maximum distortion occurred when

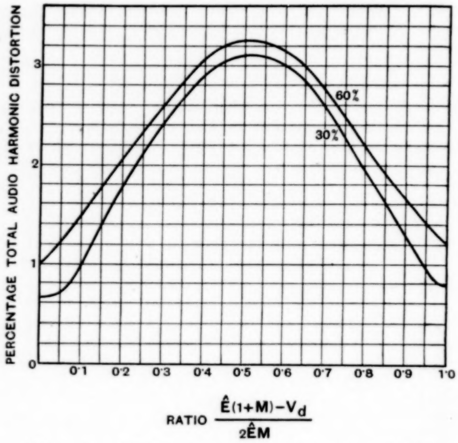


Fig. 9.—*Distortion—proportion of envelope damped curves. Delay voltage* = 20 *V*. 30 & 60% *modulation.*

$$\hat{E}_2 > V_d$$

and this has been shown above to be due to an increase in the effective delay voltage, the value of which is derived in Appendix 3*a* as follows :—

$$V_e = \frac{V_d}{\left\{1 - \frac{M}{\pi}\left(\frac{R_{DC}}{R_{AC}} - 1\right)\right\}} = \hat{E}_2$$

A similar expression for $\hat{E}_3$, the peak carrier voltage for zero distortion is given in

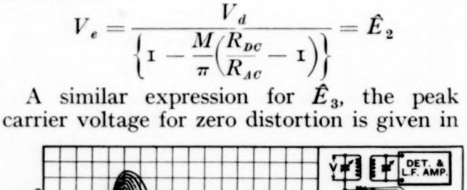


Fig. 10.—*Effect of percentage modulation on distortion produced in the audio output by the A.V.C. diode. Delay voltage* = 10 *V*.

Appendix 3*b*

$$\hat{E}_3 = \frac{V_e}{(1 - M)} = \frac{V_d}{1 - M\dfrac{R_{DC}}{R_{AC}}}$$

The values of $\hat{E}_2$ and $\hat{E}_3$ calculated from these expressions and those taken from the curves in Figs. 12*a* and *b* are tabulated below.

There is good agreement between the measured and calculated values of $\hat{E}_2$ and $\hat{E}_3$. For high ratios of $\frac{R_{DC}}{R_{AC}}$ or high percentage modulation there is a large range of carrier voltage over which distortion is very small and a measured value of $\hat{E}_3$ will in consequence be indeterminate. For example, at 60% modulation and $\frac{R_{DC}}{R_{AC}} = 1.5$ or 30% modulation and $\frac{R_{DC}}{R_{AC}} = 3$ the proportion of envelope damped $\left[\frac{\hat{E}(1 + M) - V_e}{2\hat{E}M}\right]$ is very nearly .945 at a carrier voltage of 50 compared with 1 at 100 volts carrier.

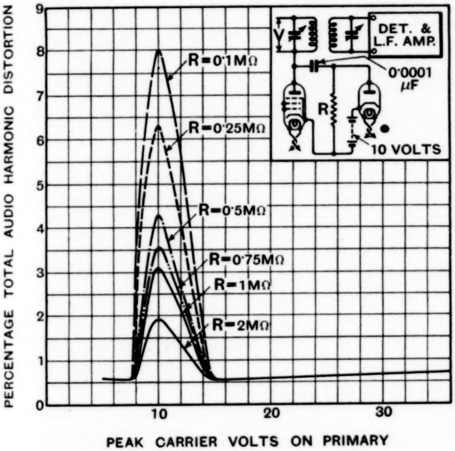


Fig. 11.—*Effect of A.V.C. diode shunt resistance on distortion produced in the audio output. Delay voltage = 10 V. 30% modulation of carrier.*

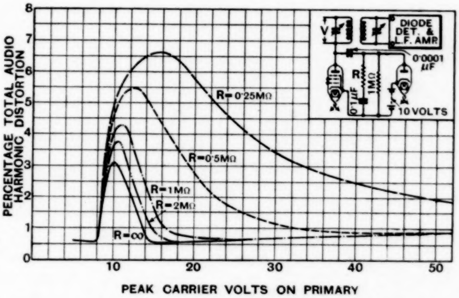
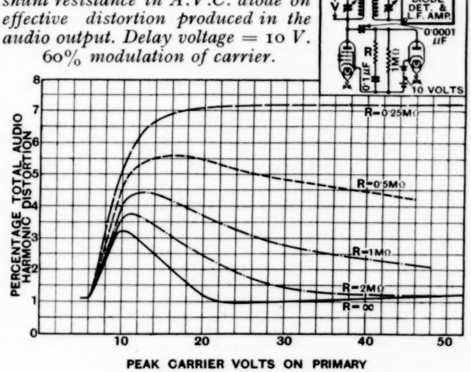


Fig. 12a.—*Effect of variation of A.C. shunt resistance in A.V.C. diode on effective distortion produced in the audio output. Delay voltage = 10 V. 30% modulation of carrier.*

Fig. 12b.—*Effect of variation of A.C. shunt resistance in A.V.C. diode on effective distortion produced in the audio output. Delay voltage = 10 V. 60% modulation of carrier.*



R_{DC}/R_{AC}	$\hat{E}_2$				$\hat{E}_3$			
	30%		60%		30%		60%	
	Calc.	Meas.	Calc.	Meas.	Calc.	Meas.	Calc.	Meas.
1	10	10	10	10	14.3	14.5	25	24.5
1.5	10.5	10.5	10.95	11	18.2	17.8	100	50
2	10.95	11	12.4	12.5	25	24.5	*	—
3	12.4	12.5	16.25	16.0	100	50	*	—
5	16.25	16	42.3	Very flat about 42	*	—	*	—

* Denotes that distortion never falls to zero.

With zero delay voltage the whole of the positive modulation envelope will be damped if

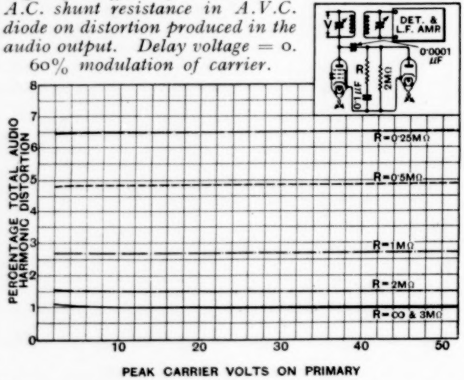
$$V_e = \hat{E}\left(1 - \frac{R_{AC}}{R_{DC}}\right) < \hat{E}(1 - M).$$

Distortion will therefore only be introduced when $V_e > \hat{E}(1 - M)$, *i.e.*, $\dfrac{R_{AC}}{R_{DC}} < M$ and its value will be independent of carrier voltage.

Curves are given in Fig. 13 for 60% modulation and $R_{DC} = 2$ mΩ. These particular constants were chosen in order to demonstrate the effects more clearly.

It has been shown above that a diode with a given D.C. shunt resistance should produce the same maximum distortion as a diode with an equivalent A.C. shunt resistance. Hence maximum values plotted against diode shunt resistance should be identical for sections 3 and 4. The thick line in Fig. 14 is a curve of maximum distortion against diode shunt resistance taken from Fig. 11 and the lower and upper dotted lines are similar curves taken from Figs. 12*a* and *b*.

Fig. 13.—*Effect of variation of A.C. shunt resistance in A.V.C. diode on distortion produced in the audio output. Delay voltage = 0. 60% modulation of carrier.*



5. *Variable Coil Impedance.*

Since distortion is introduced by damping of the anode circuit it would be expected that distortion would fall as the anode impedance is decreased and this is clearly shown by the curves in Fig. 15.

Conclusion

Distortion introduced in the modulation envelope by a diode supplying bias for A.V.C., can be reduced to small values by a suitable choice of circuit constants.

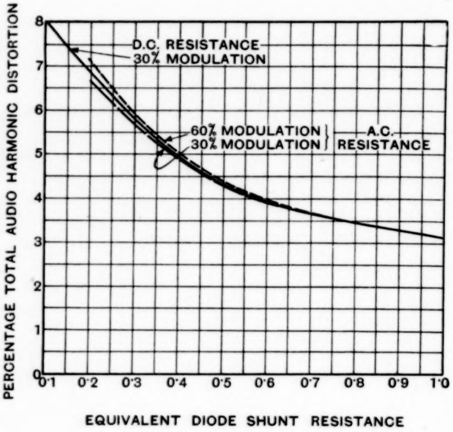


Fig. 14.—*Distortion—equivalent diode shunt resistance curves.*

(1) The D.C. shunt resistance in the diode circuit should be as high as possible, preferably not less than 1 megohm.

(2) The H.F. filter resistance should be large and not less than the D.C. resistance.

(3) The impedance of the transformer in the anode circuit of the R.F. valve should not be high, though the limit of minimum impedance will be fixed by considerations of gain and distortion produced by the R.F. valve itself. The latter will tend to increase as the anode load is reduced.

(4) The value of delay voltage is not so critical since its effect is mainly to remove distortion for small carrier voltages, and to produce a maximum value of distortion at a

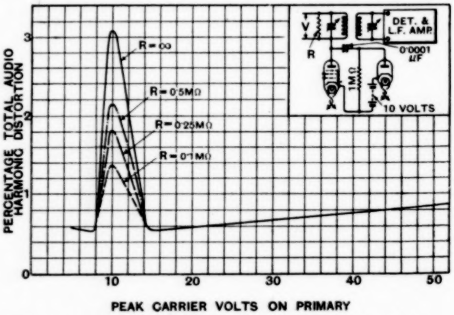


Fig. 15.—*Effect of " Q " of primary circuit on distortion produced in the audio output by the A.V.C. diode. Delay voltage = 10 V. 30% modulation of carrier.*

given carrier voltage. The delay voltage should not be so large as to give maximum distortion at a peak carrier voltage corresponding to that of the local station. For large carrier voltages there is little difference between the delayed and non-delayed condition.

This investigation was carried out in the Mazda Valve Laboratories and the author desires to record his thanks to the Cosmos Lamp Works, Limited, and in particular to Mr. E. Y. Robinson, the Chief Engineer, for permission to publish the results.

BIBLIOGRAPHY

1. Terman and Morgan, *Proceedings of the Institute of Radio Engineers*, Volume 18 (1930). "Some Properties of Grid Leak Power Detection." P. 2172.

2. H. L. Kirke, ***Wireless World***, February 3rd, 1932, "The Diode." April 30th, 1932, "More about the Diode." J. B. Lovell Foot, ***Wireless World***, December 28th, 1934, "Diode Detectors." Roberts and Williams, *J.I.E.E.*, Wireless Section, September, 1934, "Straight line detection with Diodes."

APPENDIX I

Analysis of the Anode Voltage Wave in a R.F. Amplifier containing a Diode in its Anode Circuit.

The following assumptions are made in addition to those given in the paper :—

1. The R.F. Amplifier anode current is independent of anode voltage, this implies a sinusoidal wave, $\hat{I}\cos\omega t$, if the applied grid voltage is sinusoidal.

2. The voltage across the diode coupling condenser rises during the diode conduction period and its value is given by

$$V_c' = V_c + k(t - t_1)$$

where V_c is the voltage across the condenser at the beginning of the conduction period t_1.

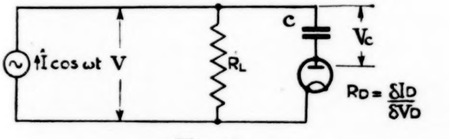


Fig. 16.

The amplifier anode circuit is equivalent to that shown in Fig. 16, where R_L is the transformer impedance. Before the diode conducts the voltage developed across the circuit will be given by

$$V = \hat{I}\cos\omega t \times R_L \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

but when conduction begins the current divides itself between the two branches. This relationship is expressed by

$$\hat{I}\cos\omega t = \frac{V}{R_L} + \frac{V - V_c'}{R_D} \quad \ldots \quad \ldots \quad (2)$$

where $1/R_D$ = diode conductance $\dfrac{\delta I_D}{\delta V_D}$

Hence

$$V = \frac{R_L \,.\, R_D}{R_L + R_D}\left[\hat{I}\cos\omega t + \frac{V_c'}{R_D}\right]$$

$$= \frac{R_L \,.\, R_D}{R_L + R_D}\hat{I}\cos\omega t + \frac{V_c \,.\, R_L}{R_L + R_D} + \frac{k(t - t_1)R_L}{R_L + R_D} \;\ldots\; (3)$$

The voltage during the conduction period is made up of a sinusoidal wave with displaced origin $\dfrac{V_C R_L}{R_L + R_D}$ and a straight line inclined at an angle $\tan^{-1}\dfrac{kR_L}{R_L + R_D}$ to the time axis. The current and voltage relationships over a complete cycle are shown in Fig. 17.

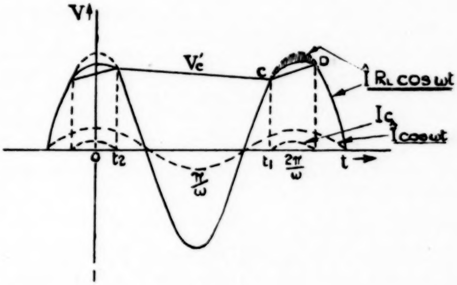


Fig. 17.

The points C and D (Fig. 17) correspond with E and G in Fig. 2*a*, and the last term in equation (3) produces the curvature of the lines EF and FG (Fig. 2*a*), which would otherwise be two straight coincident lines.

The anode voltage wave in Fig. 17 can be obtained by subtracting the shaded area from *$IR_L\cos\omega t$, and this shaded area can be analysed into its fundamental and harmonic components giving

$$f(V) = a_0 + a_1\cos\omega t + a_2\cos 2\omega t + \ldots \qquad (4)$$
$$+ b_1\sin\omega t + b_2\sin 2\omega t + \ldots .$$

where

$$a_0 = \frac{1}{2\pi}\int_{t_1}^{\frac{2\pi}{\omega}+t_2}\left(\hat{I}R_L\cos\omega t - \frac{R_L}{R_L + R_D}[\hat{I}R_D\cos\omega t + V_c + K(t - t_1)]\right)dt$$

$$a_n = \frac{1}{\pi}\int_{t_1}^{\frac{2\pi}{\omega}+t_2}\left(\hat{I}R_L\cos\omega t - \frac{R_L}{R_L + R_D}[\hat{I}R_D\cos\omega t + V_c + K(t - t_1)]\right)\cos . n\,\omega t\,dt$$

b_n gives a similar expression to a_n with $\sin . n\,\omega t$ substituted for $\cos . n\,\omega t$.

Expression (4) may be simplified to

$$f(V) = a_0 + (\sqrt{a_1^2 + b_1^2})\cos(\omega t + \phi_1) + \ldots$$
$$= \hat{I}R_L(c_0 + c_1\cos(\omega t + \phi_1) + c_2\cos(2\omega t + \phi_2) + \ldots)$$

---

* The discharge current through the diode D.C. shunt resistance is so small that it may be neglected.

The anode voltage is therefore represented by

$$\hat{V}[\cos \omega t - (c_0 + c_1 \cos(\omega t + \phi_1) + c_2 \cos(2\omega t + \phi_2) + \ldots)]$$

where $\hat{V} = \hat{I} R_L$.

APPENDIX 2

Distortion Produced in a Partially Damped Cosine Voltage Wave.

If the original voltage wave is given by $\hat{V}_1 \cos \theta$ and the damping is constant in value the resultant voltage will consist of parts of two cosine waves of different amplitude. For example, in Fig. 18, the wave is represented from A to B and C to D by the expression $\hat{V}_1 \cos \theta$ and from B to C by $\hat{V}_2 (\cos \theta - \cos \beta)$ where $\hat{V}_1 > \hat{V}_2$ and $OP = \underline{|\beta}$.

It will be noted that subtraction of the area $BECF$ which is the area $LONM (OM = EF)$ from $\hat{V}_1 \cos \theta$ will give the required voltage wave. It is only necessary to obtain the Fourier series for the curve LMN, which is part of a cosine curve $\hat{V}_3 (\cos \theta - \cos \alpha)$ where $\underline{|\alpha} = ON$, and vary $\hat{V}_1$ and $\hat{V}_3$ to obtain the distortion introduced by any degree of damping.

Fourier Series for Curve LMN.

Since the curve satisfies the equation $f(V) = f(-V)$ there will be no sine terms and it will be represented by

$$a_0 + a_1 \cos \theta + a_2 \cos 2\theta + \ldots$$

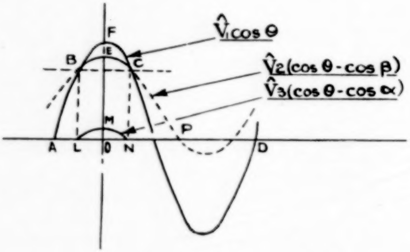
The voltage curve $ABECD$ will be given by

$$\hat{V}_1 \cos \theta - (a_0 + a_1 \cos \theta + a_2 \cos 2\theta + \ldots)$$

and the values of the coefficients a_0, a_1, etc., are

$$a_0 = \frac{\hat{V}_3}{\pi} \int_0^{\alpha} (\cos \theta - \cos \alpha)\, d\theta$$

$$a_n = \frac{2\hat{V}_3}{\pi} \int_0^{\alpha} (\cos \theta - \cos \alpha) \cos n\theta\, d\theta.$$



F
E
B
C
M
P
A
L
O
N
D
$\hat{V}_1 \cos \Theta$
$\hat{V}_2 (\cos \Theta - \cos \beta)$
$\hat{V}_3 (\cos \Theta - \cos \alpha)$

Fig. 18.

The fundamental and harmonic components of LMN are

Fundamental $\dfrac{\hat{V}_3}{\pi}\left[\alpha - \dfrac{\sin 2\alpha}{2}\right] \cos \theta$

Nth Harmonic $\dfrac{\hat{V}_3}{\pi}\left[\dfrac{\sin (n-1)\alpha}{n(n-1)} - \dfrac{\sin (n+1)\alpha}{n(n+1)}\right] \cos n\theta$

The R.M.S. value of distortion for given damping conditions ($\hat{V}_1 = m\hat{V}_3$) will be

% R.M.S. Distortion

$$= \frac{\sqrt{\sum_{n=2}^{\infty} \left[\dfrac{\sin(n-1)\alpha}{n(n-1)} - \dfrac{\sin(n+1)\alpha}{n(n+1)}\right]^2}}{\pi m - \left[\alpha - \dfrac{\sin 2\alpha}{2}\right]}$$

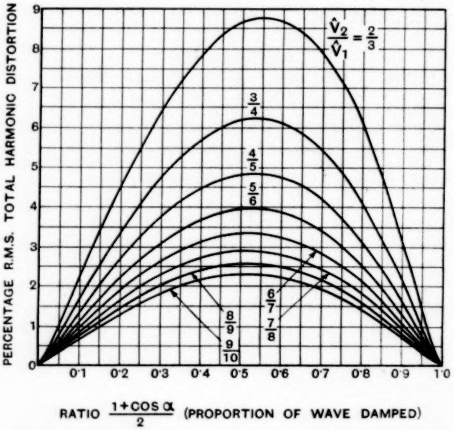


Fig. 19.—*Distortion produced by damping a sinusoidal voltage wave.*

$$\frac{\hat{V}_2}{\hat{V}_1} = \frac{\textit{Final amplitude of damped portion}}{\textit{Original amplitude of damped portion}}$$

The percentage R.M.S. distortion, calculated to the 6th harmonic is plotted in Fig. 19, against the proportion of wave damped $\dfrac{1 + \cos \alpha}{2}$ for different values of $\hat{V}^2/\hat{V}_1$.

It is to be observed that distortion reaches a maximum when the damping extends over slightly more than half the wave. When the damping is small (distortion 4%) maximum distortion is almost coincident with half wave damping.

APPENDIX 3

(*a*) *Peak Carrier Voltage for Maximum Distortion.*

Equation of line GF (Fig. 20) is

$$I_a = m[V_a - V_d]$$

Equation of line HE is

$$I_a = m'[V_a - V_e]$$

The intersection of these lines is given by

$$I_a'\left[\frac{1}{m} - \frac{1}{m'}\right] = V_e - V_a \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

Maximum distortion occurs when half the modulation envelope is attenuated, *i.e.*, when $I_a' = \frac{\hat{I}}{\pi}$

$$\hat{I}_a = m'[\hat{V}_a - V_e]$$

But $\hat{V}_a = [1 + M]V_e$

where $M =$ the percentage modulation.

$$\therefore \ \hat{I}_a = m'MV_e \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

Combining equations (1) and (2)

$$\hat{I}_a' = \frac{\hat{I}}{\pi} = \frac{m'}{\pi}MV_e = \frac{V_e - V_d}{\frac{1}{m} - \frac{1}{m'}}$$

$$\text{or} \quad V_e = \frac{V_d}{1 - \frac{M}{\pi}\left[\frac{m'}{m} - 1\right]} = \frac{V_d}{1 - \frac{M}{\pi}\left[\frac{R_{DC}}{R_{AC}} - 1\right]} \quad (3)$$

Values of M and $\frac{R_{DC}}{R_{AC}}$ which make expression (3) infinite or negative mean that maximum distortion is never reached.

(*b*) *Peak Carrier Voltage for Zero Distortion.*

Zero distortion will occur when all the positive modulation envelope is damped, *i.e.*, when $\hat{E}_3[1 - M] = V_e$

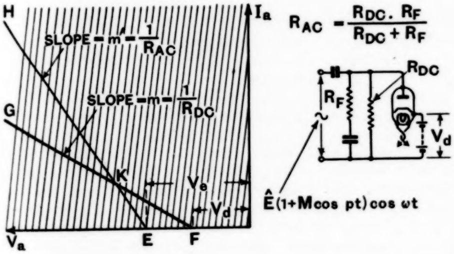


Fig. 20.

The intersection of HE and GF is given by

$$m[V_a - V_d] = m'[V_a - V_e] \quad \ldots \quad \ldots \quad (1)$$

where $V_a = \hat{E}_3 = \frac{V_e}{1 - M}$.

Hence

$$V_e = \frac{V_d}{1 - \frac{M}{1 - M}\left[\frac{m'}{m} - 1\right]}$$

$$= \frac{V_d}{1 - \frac{M}{1 - M}\left[\frac{R_{DC}}{R_{AC}} - 1\right]} \quad \ldots \quad \ldots \quad (2)$$

$$\therefore \ \hat{E}_3 = \frac{V_d}{1 - M - M\left[\frac{R_{DC}}{R_{AC}} - 1\right]} = \frac{V_d}{1 - M\frac{R_{DC}}{R_{AC}}} \quad \ldots \quad (3)$$

When expression (3) is negative or infinite distortion will always be present.

(*c*) *Percentage Modulation for Zero Distortion with no Delay.*

When $V_d = 0$

the equation of GF becomes

$$I_a = mV_a$$

and that of HE

$$I_a = m'[V_a - V_e]$$

At the point of intersection the following equation is true

$$V_e = V_a\left[1 - \frac{m}{m'}\right] = V_a\left[1 - \frac{R_{AC}}{R_{DC}}\right].$$

For zero distortion $V_a = \hat{E}$

and $V_e \lesssim \hat{E}[1 - M]$

thus $M \lesssim \frac{R_{AC}}{R_{DC}}$ is the condition for zero distortion with non-delayed A.V.C.

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A NEW album of five special H.M.V. records for purposes of test and demonstration has now been issued. The series is fully described in a leaflet available from the Gramophone Co., Ltd., 98–108, Clerkenwell Road, London, E.C.1.

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THE fourteenth edition of the Radio Amateur's Handbook contains 21 chapters devoted to the design, construction and operation of experimental short- and ultra-short wave apparatus. Considerable space is devoted to the subject of transmission, and though equipment of comparatively high-power predominates, the requirements of those restricted to the use of low-power apparatus has not been overlooked. Likewise, simple as well as quite elaborate short-wave receivers are described in detail.

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H. B. D.

Abstracts and References

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For the information of new readers it is pointed out that the length of an abstract is generally no indication of the importance of the work concerned. An important paper in English, in a journal likely to be readily accessible, may be dealt with by a square-bracketed addition to the title, while a paper of similar importance in German or Russian may be given a long abstract. In addition to these factors of difficulty of language and accessibility, the nature of the work has, of course, a great influence on the useful length of its abstract.

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PROPAGATION OF WAVES

1. EXPERIMENTAL INVESTIGATIONS OF VERY LONG WAVES REFLECTED FROM THE IONOSPHERE.—J. E. Best, J. A. Ratcliffe & M. V. Wilkes. (*Proc. Roy. Soc.*, Series A, 1st Sept. 1936, Vol. 156, No. 889, pp. 614–633.)

These experiments were "carried out to determine the characteristic features (amplitude, height of reflection, and polarisation) of waves" of length 18.8 km "reflected from the ionosphere at fairly small angles of incidence." The ground interference pattern was measured at distances between 70 and 140 km from the emitter. "There was a marked change in equivalent reflection height in passing from day to night." Approximate values for the reflection coefficients were deduced. Sunset and sunrise variations were also observed at a fixed point. It was found that, "in winter, the [down-coming] wave was approximately circularly polarised with a left-handed sense. . . . the equivalent reflection height increased by about 12 km from day to night. The relation of these results to those of previous workers is discussed and certain theoretical conclusions are deduced."

2. IONOSPHERIC REGIONS AND A SOLAR ECLIPSE.—G. Leithäuser & B. Beckmann. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 17, 1936, pp. 327–329.)

A (P', t) record is given [the wavelength is not directly stated but from later remarks it is gathered to have been 60 m] for reflection from the ionosphere during the solar eclipse of 19.6.1936. A decrease of ionisation took place as the visible area of the sun decreased; this was not however followed by an increase as the visible area increased again. There was a further rapid decrease which lasted during the whole day. The explanation offered is that the ionosphere does not take part in the earth's rotation, so that the observing station approached the totality zone as the day went on. It is also found to be probable "that the ionisation of the upper regions is not due to the sun's light but to electrons emitted by the sun."

3. THE PROPAGATION OF ATMOSPHERIC DISTURBANCES AND THE RECEPTION OF DISTANT STATIONS DURING THE SOLAR ECLIPSE [of 19.6.1936].—G. Leithäuser & W. Menzel. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 17, 1936, pp. 330–332.)

The (P', t) record referred to in the above abstract is compared with the record of the total component of atmospheric disturbances round a wavelength of 32 m during the same time. The atmospheric curve is found to be parallel to the height of the ionosphere. This fact and the data of reception from distant stations (Fig. 4) are considered to support the hypothesis of non-rotation of the ionosphere, particularly as regards the geographical situation of the stations and the relative times at which reception from them was disturbed. The writers think that in future eclipses it will be possible to prophesy what short-wave traffic will be workable; they attach particular importance to the slow recovery of ionisation in the ionospheric regions affected by the eclipse.

4. OBSERVATIONS ON THE CONDITION OF THE IONOSPHERE DURING THE SOLAR ECLIPSE OF 19TH JUNE, 1936 [with Curves of Squares of Critical Frequencies for E and F_2 Regions].—I. Ranzi. (*La Ricerca Scient.*, 15th/30th Sept. 1936, 7th Year, Vol. 2, No. 5/6, pp. 327–330.)

The E curve presents no particular interest: in the F_2 curve the important fact is that there are two minima, one about 30 minutes before, and the other about 20 minutes after, the eclipse maximum. The timing of the first minimum suggests the existence either of a neutral corpuscular radiation with a velocity little less than that of light (not so low as that supposed by Milne) or perhaps of an electronic radiation such as is proposed by Dauvillier (of about 10^{10} electron-volts energy), forced by the action of the terrestrial magnetic field into a path almost concentric with the earth's surface, and at a distance from it of the order of the earth's radius, and producing, by collision with the gas molecules, a secondary radiation of slow electrons. The fact that the minimum electronic density during the eclipse is lower than the nocturnal minimum supports this hypothesis.

5. Meteor Heights from the Arizona Expedition [including " Night Effect " probably due to Nocturnal Cooling by Radiation : Annual Fluctuation of Height of Atmosphere (3.7 ± 0.7 km) : Conclusions as to Temperature and Structure of Atmosphere around 90 km].—E. Öpik. (*Proc. Nat. Acad. Sci.*, 15th Sept. 1936, Vol. 22, No. 9, pp. 525–530.)

6. Atmospheric Oscillations [Reconciliation of Facts of Pressure Oscillations assuming Temperature Distribution with Maximum at 60 km Height : Anomalous Variation of Height and Ionisation of F_2 Region may be associated with Semidiurnal Atmospheric Oscillation].—C. L. Pekeris. (*Nature*, 10th Oct. 1936, Vol. 138, pp. 642–643.)

7. Comparison of Data on the Ionosphere, Sunspots, and Terrestrial Magnetism [1930–1935 : dealing mainly with F_2 Region : No Direct Relation between SunspotNumbers and Daily or Monthly Averages of Critical Frequencies : Good Correlation with Yearly Averages : etc.].—E. B. Judson. (*Journ. of Res. of Nat. Bur. of Stds.*, Sept. 1936, Vol. 17, No. 3, pp. 323–330.) A preliminary version of this paper was read at the I.R.E. Detroit Convention (2932 of 1935).

8. The Great Solar Eruption of 28.8.1936 [Hydrogen, Helium and Sodium Flocculi : Associated Magnetic Disturbances : General Geophysical Effects of Solar Eruptions].—M. Waldmeier. (*Naturwiss.*, 2nd Oct. 1936, Vol. 24, No. 40, pp. 638–639.)

9. Interruptions in Short-Wave Communication [Dellinger 54-Day Fade-Out].—E. V. Appleton. (*World-Radio*, 30th Oct. 1936, Vol. 23, pp. 9 & 11.)

10. The Lower Ionosphere [Description of Apparatus used in Investigation of C and D Regions : Circuit Diagrams of Transmitter and Receiver : Receiver Aerial a Universally-Mounted Loop : Results : Various Forms of Oscilloscope Pattern].—R. C. Colwell & A. W. Friend. (*Phys. Review*, 1st Oct. 1936, Series 2, Vol. 50, No. 7, pp. 632–635.) *See* also 2508 of 1936.

11. The Production and Use of Short Electrical Impulses [and the Latest Circuit used in " C "-Layer Investigations].—Colwell, Friend & Hall. (*Review Scient. Instr.*, Nov. 1936, Vol. 7, No. 11, pp. 420–422.) *See* also 3300 of 1936. The older mercury-vapour or gas triode circuit has been modified by replacing the condenser-charging resistance by a diode. Perfect reliability and synchronisation are obtained.

12. Influence of the Earth's Magnetic Field on the Propagation of Hertzian Waves in the Ionosphere.—De Pace : Todesco. (*Alta Frequenza*, Oct. 1936, Vol. 5, No. 10, pp. 651–657.)

Continuation of the argument dealt with in 3680 of 1936. De Pace here maintains that his 1929 experiments proved the influence of the magnetic field both as regards the anomalous variation of the phase velocity and as regards the absorption of waves of about 200 m length ; that Todesco's 1931 researches proved only the point regarding the absorption ; and finally that he himself has carried out new experiments on lines analogous to those of Todesco, giving results which are irreconcilable with Todesco's conclusions.

13. Radio Waves change Speed [Transatlantic Radio Waves travel at Half Velocity on Some Days : Waves passing near Magnetic Pole show Velocity of only 200×10^6 m/s].—H. T. Stetson. (*Electronics*, Sept. 1936, Vol. 9, No. 9, pp. 64, 65.) Summary of paper on international time signal tests.

14. The Propagation of Radio Waves over the Surface of the Earth and in the Upper Atmosphere : Part I—Ground-Wave Propagation from Short Antennas [Sommerfeld Equations reduced to Simple Diffraction and Attenuation Formulae and Graphs : Limitations shown by Comparison with Experimental Data].—K. A. Norton. (*Proc. Inst. Rad. Eng.*, Oct. 1936, Vol. 24, No. 10, pp. 1367–1387.)

15. Sommerfeld's Formula [Simplifications for Practical Use on Broadcasting Wavelengths, with Seven Charts and Correction Curves based on Actual Surveys].—W. A. Fitch. (*Electronics*, Sept. 1936, Vol. 9, No. 9, pp. 23–25.)

16. The Propagation of Ultra-Short Electromagnetic Waves [Survey].—P. Labat. (*L'Onde Élec.*, Oct. 1936, Vol. 15, No. 178, pp. 617–644). Lecture to the Société des Radioélectriciens : to be continued (not in Nov. issue).

17. Ultra-Short-Wave [Alexandra Palace Television] Service Area.—Scroggie. (*See* 210.)

18. Electron Velocity Distributions in Gases [Frequent Existence of Wide Depression in Distribution Function for Electron Velocities rather greater than the Mean : Distinct Group of Electrons with Mean Energy 5–10 Electron Volts].—K. G. Émeleus & R. J. Ballantine. (*Phys. Review*, 1st Oct. 1936, Series 2, Vol. 50, No. 7, pp. 672–673.)

19. Electron Motion in a Plasma [taking Electron Gas Pressure Gradients into Account].—Linder. (*Science*, 16th Oct. 1936, Vol. 84, pp. 353–354.) *See* also 2914 of 1936.

20. Ionisation, Excitation and Chemical Reaction in Uniform Electric Fields. II—The Energy Balance and Energy Efficiencies for the Principal Electron [Collision] Processes in Hydrogen.—R. W. Lunt & C. A. Meek. (*Proc. Roy. Soc.*, Series A, 1st Oct. 1936, Vol. 157, No. 890, pp. 146–166.) For I *see* 3983 of 1936.

21. Production of After-Glow in Active Nitrogen [Experimental Results: Explanations including Effect of Containing Walls].—G. Cario & U. Stille. (*Zeitschr. f. Physik*, No. 5/6, Vol. 102, 1936, pp. 317–330.)

22. Transmission of Electromagnetic Waves in Hollow Tubes of Metal [including Multiplex Transmission in a Single Pipe-Line: Use as High-Pass Filter: Horn Radiators for Ultra-Short Waves (may be fed also by Coaxial or Other Lines): etc.].—W. L. Barrow. (*Proc. Inst. Rad. Eng.*, Oct. 1936, Vol. 24, No. 10, pp. 1298–1328.) A summary was dealt with in 3665 of 1936.

23. Modified Sommerfeld's Integral and Its Applications [to the Radiation of Electromagnetic Waves in Hollow Cylindrical Conductors and from Parallel Wires in Space].—Schelkunoff. (*See* 108.)

24. Propagation and Reception of Wireless Waves under Water [Bibliography].—(*Science Library Bibliographical Series*, No. 261, 1936, 2 pp: at Science Library, Science Museum, South Kensington, S.W.7.)

25. The Propagation of Potential in Discharge Tubes.—Snoddy, Beams & Dietrich. (*Phys. Review*, 1st Sept. 1936, Series 2, Vol. 50, No. 5, pp. 469–471.) The full paper; for preliminary letter *see* 3685 of 1936.

26. On Concentric Lines [for Wide-Band Transmission: the Question of Interference and Cross-Talk from External Circuits: Disagreement between Theory and Experiment].—A. Matsumoto. (*Nippon Elec. Comm. Engineering*, Sept. 1936, No. 4, p. 356: summary only, in English.)

27. Corrections to Papers on Propagation of Electromagnetic Phenomena in Media of Cylindrical Structure.—F. Pollaczek. (*Rev. Gén. de l'Élec.*, 10th Oct. 1936, Vol. 40, No. 15, p. 476.) For the papers in question *see* 3689 of 1936.

28. Dispersion of Short Electric Waves in Solid Bodies [Dielectrics: No Dispersion in Range 12–200 cm].—H. Slätis. (*Acta acad. Abo: math. & phys.*, Vol. 9, p. 4: abstract only in *E.T.Z.*, 29th Oct. 1936, Vol. 57, No. 44, p. 1270.)

29. Some Theoretical Considerations on Anomalous Diffraction Gratings.—U. Fano. (*Phys. Review*, 15th Sept. 1936, Series 2, Vol. 50, No. 6, p. 573.) *See* also 37 & 889 of 1936 (Strong, Wood).

30. The Optical Constants of Thin Silver Films. Reply to a Paper by H. Murmann [Thickness of Film determines whether Optical Properties at Air and Quartz Surfaces are the same or different].—F. Goos. (*Zeitschr. f. Physik*, No. 9/10, Vol. 102, 1936, p. 702.) For Goos's original paper *see* 2532 of 1936.

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

31. Canadian Correlation between Direction of Sources of Atmospherics and Meteorological Conditions.—J. T. Henderson. (*18th Ann. Rep. of Nat. Res. Council*, Canada, 1934–1935, p. 65.) Paragraph only: *see* also 3779 of 1935.

32. Results of the Observations of the Polish Polar Year (1932/33) Expedition at Bear Island: Part III—Atmospherics. Part IV. Polar Auroras.—Lugeon, Centkiewicz & Lysakowski. (Published in 1936 by the *Drukarnia Pánstwowego Instytutu Meteorologiczcnego*, Warsaw: with concurrent French translation.)

33. The Propagation of Atmospheric Disturbances and the Reception of Distant Stations during the Solar Eclipse.—Leithäuser & Menzel. (*See* 3.)

34. An Electronic-Relay for the Automatic Setting with Action of a Cathode-Ray Oscillograph [for recording Atmospherics].—P. Fourmarier. (*Rev. Gén. de l'Élec.*, 3rd Oct. 1936, Vol. 40, No. 14, pp. 441–442: summary only, with diagrams.)

35. Lightning and Atmospherics [Type giving Crackling in Receiver before Visual Observation of Flash is rarer than Simpler Types].—P. R. Coursey. (*Nature*, 19th Sept. 1936, Vol. 138, p. 509.) *See* 3690 of 1936.

36. Photographic Study of Lightning [with Rotating Film Cameras: Three Types of Electrical Breakdown: Possible Mechanism for Lightning Breakdown on Principle of Cascaded Spark Gaps].—Workman, Beams & Snoddy. (*Physics*, Oct. 1936, Vol. 7, No. 10, pp. 375–379.)

37. The Lightning Stroke: Mechanism of Discharge.—McEachron & McMorris. (*Gen. Elec. Review*, Oct. 1936, Vol. 39, No. 10, pp. 487–496.)

38. The Thunderstorm [Heat, Mountain, Cold-Front, Overrunning-Cold-Front and Warm-Front Types: Comparison of Electrification Theories: Humphrey's Theory of Maintenance: etc.].—E. A. Evans & K. B. McEachron. (*Gen. Elec. Review*, Sept. 1936, Vol. 39, No. 9, pp. 413–425.)

39. Electrification of a Roof during a Thunderstorm [Partially Insulated Roof became charged as One Plate of Condenser].—W. F. Tyler. (*Nature*, 24th Oct. 1936, Vol. 138, p. 724.)

40. Propagation of [Waves in General and] Surges on Groups of Parallel Cables [Fundamental Differential Equations: Characteristic Properties of Equivalent Conductors: Reflection Phenomena at Junctions: Effect of Lightning Strokes on Insulation of High Voltage Masts: etc.].—H. Schwenkhagen. (*Arch. f. Elektrot.*, 8th Sept. 1936, Vol. 30, No. 9, pp. 604–623.)

41. A Cosmic Cyclotron [formed by a Double Star] as a Cosmic Ray Generator?—H. Alfvén. (*Nature*, 31st Oct. 1936, Vol. 138, p. 761.)

42. On the Allowed Cone of Cosmic Radiation [Theoretical Determination of Asymptotic Trajectories of Charged Particles in Earth's Magnetic Field using Bush's Differential Analyser].—Lemaitre & Vallarta. (*Phys. Review*, 15th Sept. 1936, Series 2, Vol. 50, No. 6, pp. 493–504.) *See* also 2901 of 1936.

43. Apparatus for transmitting Cosmic-Ray Data from the Stratosphere [Exploring Balloon Equipment with Neon-Tube Flasher to modulate R.F. Transmitter: Atmospheric Pressure and Cosmic-Ray Information both given by Flash Frequency].—R. L. Doan. (*Review Scient. Instr.*, Nov. 1936, Vol. 7, No. 11, pp. 400–406.)

44. A Continuously Active Cloud Chamber [using HCl Vapour and Water Vapour].—Vollrath. (*Review Scient. Instr.*, Nov. 1936, Vol. 7, No. 11, pp. 409–410.)

45. Atmospheric Potential Gradient Anomalies [Correlation with Positions of Sunspots and Weather Conditions].—F. L. Cooper. (*Physics*, Oct. 1936, Vol. 7, No. 10, pp. 387–394.)

46. Relations between the Electric Field of the Atmosphere and Some Meteorological Factors during the Year 1934 at the Observatory of Ksara (Lebanon).—J. Chevrier. (*Comptes Rendus*, 12th Oct. 1936, Vol. 203, No. 15, pp. 674–676.)

47. Variations of Earth Current [observed along German Telegraph Cables] and Terrestrial Magnetism during the Polar Year 1932/33.—R. Bock & F. Moench. (*E.N.T.*, Oct. 1936, Vol. 13, No. 10, pp. 331–335.)

Curves are given which show agreement " down to the smallest details " between the earth-current variations and those of the two horizontal components of the earth's magnetic field; the earth current varies with whichever of the components is most active at any time. There are however differences between the curves for the mean values over periods of several hours.

48. The Nature of Magnetic Perturbations [Study of Initial Impulse in Magnetic Storm: Bay Disturbances].—M. Bossolasco. (*Comptes Rendus*, 12th Oct. 1936, Vol. 203, No. 15, pp. 676–678.)

PROPERTIES OF CIRCUITS

49. Theory of Modulation and Demodulation. Parts I and II.—F. Aigner & C. L. Kober. (*Hochf:tech. u. Elek:akus.*, Aug. 1936, Vol. 48, No. 2, pp. 59–67: Sept. 1936, No. 3, pp. 99–107.)

I. This treatment develops the mathematical theory of modulated oscillations on modern lines and proves the reality of sidebands from an existence theorem in the theory of integral equations, after the differential equation which is the mathematical expression of modulation has been transformed into an integral equation. The pseudo- and quasi-harmonic differential equations are worked out and their connections with technical modulation methods are analysed. Operational methods are applied to the consideration of transient phenomena and their effect with amplitude-, frequency- and phase-modulation; in the last-named a phase displacement occurs which has the effect of a non-linear distortion when demodulation takes place, and is a fundamental (though secondary) difference between phase- and frequency-modulation.

II. The theory of demodulation by rectification is worked out and its connection with technical demodulation methods is analysed. The theory of beats and the part they play in modulation are considered in the light of the principle of superposition. Beats of higher order than the first are regarded as arising from the superposition of several oscillations. The transition to beats of infinite order leads to the Fourier series and integral; two paradoxes in the analysis of short telegraphic signals are discussed. A list of literature references is appended.

50. The Stability of the Ampli-Filter [with " Suppressive " Feed-Back to increase Attenuation in Attenuating Band and Rectified Feed-Back to increase Gain in Pass Band] and Its Method of Improvement.—H. Nukiyama. (*Nippon Elec. Comm. Engineering*, Sept. 1936, No. 4, pp. 322–323: in English.) The danger of self-oscillation, present in the original ampli-filter, is avoided in the new type by the use of rectified feed-back, which has no regenerative action.

51. The Practical Realisation of A.C. Impedances by the Method of W. Cauer with Application of Partial Fractions [Two Examples explaining how to calculate the Optimum Circuits and Circuit Elements for a Given Problem on Cauer's Theory].—K. Steffenhagen. (*E.N.T.*, Oct. 1936, Vol. 13, No. 10, pp. 357–361.) For Cauer's work *see* 1932 Abstracts, pp. 50 & 537; *see* also Glowatzki, 1934 Abstracts, pp. 50 & 266–267.

52. Band Filter consisting of Two Oscillating Circuits coupled Capacitatively [by Star- or Three-Point Circuit consisting of Two Condensers and a Resistance].—B. D. H. Tellegen: Philips Company. (*Hochf:tech. u. Elek:akus.*, Aug. 1936, Vol. 48, No. 2, p. 74: German Pat. 626 419 of 14.8.1934.)

53. Voltage Resonance and Its Applications.—Beauvilain. (*See* 275.)

54. ON SOME OSCILLATION PROBLEMS LEADING TO FUNCTIONAL EQUATIONS.—V. Bovsheverov. (*Journ. of Tech. Phys.* [in Russian], No. 9, Vol. 6, 1936, pp. 1480–1488.) An abridged version, in French, was dealt with in 3329 of 1936.

55. SOME NEW EXPERIMENTS ON FREQUENCY DEMULTIPLICATION IN AN OSCILLATING CIRCUIT WITH IRON-CORED COIL [Regions of Stability: Effect of Number of Turns and Curvature of Magnetic Characteristic of Coil on Order of Demultiplication obtainable: Existence of Oscillations whose Period is not a Whole Multiple of That of the Source].—E. Rouelle. (*Comptes Rendus*, 19th Oct. 1936, Vol. 203, No. 16, pp. 712–714.) For previous work *see* 981 of 1935; *cf.* also Aretz, 2119 of 1936.

56. CALCULATION OF NON-LINEAR DISTORTIONS [in Transmission Systems: Method based on Representation of Fields of Characteristic Curves by Orthogonal Functions, particularly the Bessel Function System: Rectifier and Magnetisation Characteristics: Explanation of a Filter Effect by Vanishing of Some Harmonics at Zeros of Bessel Functions].—C. L. Kober. (*E.N.T.*, Oct. 1936, Vol. 13, No. 10, pp. 336–340.) *See* also 2217 and 3366 of 1935; *also* Strutt, 1934 Abstracts, p. 614.

57. ON A SPECIAL FREQUENCY CHARACTERISTIC FOR ESTIMATING DISTORTION.—A. A. Kharkevich. (*Journ. of Tech. Phys.* [in Russian], No. 9, Vol. 6, 1936, pp. 1551–1560.)

When the performance of a system is represented by a frequency-response characteristic, a number of additional calculations are required for estimating the distortion introduced by the system. In the present paper an equation (13) is derived which is based on the integral of squared error (5) and which gives a direct indication of the distortion of a standard signal when this is passed through the system. The discussion is illustrated by an example, and methods are indicated for obtaining these curves experimentally. Some typical curves are shown. For a previous paper *see* 4001 of 1936.

58. ON THE OPERATION OF AN OVER-DRIVEN VALVE.—S. I. Evtyanov. (*Izvestiya Elektroprom. Slab. Toka*, No. 8/9, 1936, pp. 26–29.)

A valve is said to be over-driven when it is biased beyond the cut-off and the positive grid swings momentarily exceed the anode voltage; the latter condition is characterised by the appearance of a trough at the top of the anode-current impulse. In the present paper, starting from the assumption that the dynamic characteristic of the anode current has the shape of a triangle, a number of formulae are derived determining various operating constants such as the duration of the anode-current impulse, depth of the trough, power output, etc. A numerical example is given which has been verified experimentally.

59. ELECTRON-COUPLED OSCILLATORS [and Two Fallacies concerning This Coupling].—(*World-Radio*, 18th Sept. 1936, Vol. 23, p. 16.)

60. ON THE PAPER "ELECTRO-MECHANICAL ANALOGIES."—A. Charkewitsch: Warshavsky & Fedorovich. (*Journ. of Tech. Phys.* [in Russian], No. 8, Vol. 6, 1936, pp. 1436–1437.) *See* 2549 of 1936.

TRANSMISSION

61. A NEW ELECTRON OSCILLATOR [New Arrangement of Electrodes in Vacuum Tube with Magnetic Field produces Strong Centimetre Waves of Continuously Variable Length and Non-Critical Adjustment].—K. Okabe. (*Nature*, 17th Oct. 1936, Vol. 138, pp. 685–686.)

62. MULTI-TUBE OSCILLATORS FOR THE ULTRA-HIGH FREQUENCIES.—P. D. Zottu. (*QST*, Oct. 1936, Vol. 20, No. 10, pp. 21–23 and 74, 76.) For previous references *see* 2553 of 1936.

63. MECHANISM OF THE OSCILLATIONS IN THE SPLIT-ANODE MAGNETRON [Theory].—H. G. Möller. (*Hochf:tech. u. Elek:akus.*, Oct. 1936, Vol. 48, No. 4, pp. 133–140.)

For previous work *see* 2951 of 1936. Here the calculations are extended to the case of unequal potentials on the anodes; the electron paths are calculated, and the static characteristics and the mechanism of long-wave oscillations are deduced. "The case is also considered in which the magnetic field completely 'locks' the electrons within the anode, *i.e.*, their paths turn back before they reach the anode. The ring current calculated in the previous paper is then found to 'breathe,' *i.e.*, the turning-point of the paths fluctuates with alternating voltage on the anode. This induces a current in the anode and the connected inductance which may excite a short-wave oscillation." *See* also next abstract.

64. MEASUREMENT OF THE ELECTRON RING CURRENT IN THE MAGNETRON.—J. Möller. (*Hochf:tech. u. Elek:akus.*, Oct. 1936, Vol. 48, No. 4, pp. 141–142.)

A circuit is given for measuring the electron ring current postulated in 2951 of 1936 and discussed in the paper referred to above; its magnetic field is compared ballistically with that of a current in a cylinder of the same dimensions as the magnetron anode. The measurements agreed well with the theory.

65. THE STATIC CHARACTERISTICS OF THE SPLIT-ANODE MAGNETRON [theoretically deduced from Electron Paths: Mathematical Verification].—H. Zuhrt. (*Hochf:tech. u. Elek:akus.*, Sept. 1936, Vol. 48, No. 3, pp. 91–98.)

66. MAGNETRON ARRANGEMENT [Heating Current led to Filament along Iron Core of Field Magnet].—Kühle, Prinz & Herriger: Telefunken. (*Hochf:tech. u. Elek:akus.*, Sept. 1936, Vol. 48, No. 3, p. 108: German Pat. 629 267 of 6.7.1934.)

67. Equivalent Networks of Negative-Grid Vacuum Tubes at Ultra-High Frequencies [Usual Delta Network made applicable where Transit-Time Effects are Appreciable but Moderately Small, by Addition of Series Resistors: Network for Still Higher Frequencies: etc.].—F. B. Llewellyn. (*Bell S. Tech. Journ.*, Oct. 1936, Vol. 15, No. 4, pp. 575–586.)

68. A Wavelength Control [for Ultra-Short Waves: Rectangle of 1" Copper Tube with Sliding Cross-Piece].—D. Taylor. (*Journ. Scient. Instr.*, Oct. 1936, Vol. 13, No. 10, pp. 333–334.)

69. 5-Metre Crystal-Control with Push-Pull Type 800 Output [200-Watt Input].—J. L. Reinartz. (*QST*, Oct. 1936, Vol. 20, No. 10, pp. 24–25 and 76, 78.)

70. Frequency Stability of Valve Oscillators: the Influence of Grid Current [Not always Explicable by Simple Resistive Damping: the Importance of the Value of Leakage Reactance].—D. A. Bell. (*Wireless Engineer*, Oct. 1936, Vol. 13, No. 157, pp. 539–543.) "The general conclusion is that, provided suitable coupling (of small leakage reactance) is employed, the presence of appreciable grid current need not cause noticeable loss of stability." An appendix extends the treatment to non-linear oscillators.

71. Valve Amplifiers [for Connection inside a Concentric Power Lead: Scheme of Connections].—Le Matériel Téléphonique. (*Hochf:tech. u. Elek:akus.*, Sept. 1936, Vol. 48, No. 3, p. 109: French Pat. 799 521 of 22.1.1935.)

72. Measurement of the "Angle of Circulation" in Amplifiers.—U. Tiberio. (*Alta Frequenza*, Oct. 1936, Vol. 5, No. 10, pp. 611–629.)

A method is described for the approximate measurement of the fraction of a period during which electronic current passes through an amplifier valve not working as a Class A type. The method is based on the determination of the ratio of the mean and effective values, or the mean and maximum values, of the anode current; it is valid when—as is usually the case—the current can be considered as sinusoidal during the "circulation" interval. These two variations of the method are dealt with in §§ 2 & 3, while § 4 describes another method using a cathode-ray oscillograph, and § 5 yet another method, an indirect one based on the measurement of the equivalent resistance of the oscillatory anode circuit. § 6 shows the quite good agreement (within about 10%) between the results of the four methods.

When this fraction of the period (the "circulation angle") is known, it is possible to deduce by simple measurements the conversion efficiency of the amplifier.

73. On the Effect of the Frequency Properties of the Load on a Valve Oscillator on the Modulation.—G. S. Ramm. (*Izvestiya Elektroprom. Slab. Toka*, No. 8/9, 1936, pp. 18–26.)

Author's summary:—A new equivalent circuit for Class B valve oscillators with cosine current form is given. By means of this circuit a new formula is deduced which connects the addition of the modulating factor and the first harmonic of the plate current; it takes into account the frequency properties of the oscillator load. From this formula, design formulae are obtained for the first-harmonic modulation factor of the plate current (for grid-bias modulation) and for the amplification of the modulated oscillations. For the latter case a formula is given for the calculation of the modulation-factor change when working with a cut-off differing from 90°. Finally, by means of the same formula, formulae are obtained for the calculation of demodulation caused by the existence of a filter in the plate-supply circuit.

74. Modulation Circuit [using Two Valves with Anode Circuits in Parallel: Grids receive One Oscillation in Phase, the Modulating Oscillation out of Phase: Working Characteristics of Valves have Opposite Curvatures and cancel Overtones].—H. Tischner: A.E.G. (*Hochf:tech. u. Elek:akus.*, Aug. 1936, Vol. 48, No. 2, p. 74: German Pat. 627 207 of 13.9.1934.)

75. The Making Visible of the Sidebands in Amplitude Modulation [by 30-Reed Frequency Meter supplied by 50 c/s Current 100% modulated 5 Times per Second].—E. Dahl. (*Funktech. Monatshefte*, Oct. 1936, No. 10, p. 392.)

76. Broadcasting with Carrier and Single Sideband.—Siforov. (*See* 396.)

77. A Note on Sideband Phase Distortion.—Johnstone & Wright. (*See* 86.)

78. Theory of Modulation and Demodulation [Amplitude, Frequency and Phase Modulation].—Aigner & Kober. (*See* 49.)

79. Correction to "Modulation with Variable Carrier."—Harbich, Gerth & Pungs. (*Hochf:tech. u. Elek:akus.*, July, 1936, Vol. 48, No. 1, p. 33.) Correction to Fig. 10 in the paper dealt with in 3343 of 1936.

80. Radio-Telegraph Transmitter Model GRT-10E.—Tokyo Elec. Rad. Company. (*Nippon Elec. Comm. Engineering*, Sept. 1936, No. 4, pp. 303–314: in English.)

RECEPTION

81. Reception Disturbances due to Apparatus for Ultra-Short-Wave Diathermy.—A. Esau & O. H. Roth. (*Hochf:tech. u. Elek:akus.*, Oct. 1936, Vol. 48, No. 4, pp. 113–117.)

The investigation concerns sound and picture reception on the wavelength range 5.5 to 7.5 m. The range of the disturbances is found to depend on the buildings in the neighbourhood; reinforced concrete buildings give a marked decrease of interference. In picture reception the disturbances may produce a tattered appearance on the raster (Figs. 8–16); characteristic differences between damped and undamped emitters are noted. Explosion motors give sparkle and spot effects on the raster (Figs. 6, 7) which are decreased by fixing resistances in the connections to the sparking plugs. Diathermal apparatus may be shielded in metal boxes or wire gauze cages, provided the latter are completely closed. Comparatively large radii of disturbance were found.

82. The Electrical Characteristics of 132-kv Line Insulators under Various Weather Conditions [and the Development of a Testing Technique].—J. E. Forrest. (*Journ. I.E.E.*, Oct. 1936, Vol. 79, No. 478, pp. 401–423.)

83. Radio Interference: Suppression of Troubles due to Television Transmissions.—Belling & Lee, Ltd. (*Electrician*, 23rd Oct. 1936, Vol. 117, p. 498.) Notice of Bulletin No. 31.

84. Inherent Receiver Noise [Nature and Evaluation].—A. L. M. Sowerby. (*Wireless World*, 9th and 18th Oct. 1936, Vol. 39, pp. 373–375 & 414–416.)

85. A Crystal Filter and Noise-Silencer for the "High-Performance" Super.—G. Grammer. (*QST*, Oct. 1936, Vol. 20, No. 10, pp. 28–30 and 84, 86.)

86. A Note on Sideband Phase Distortion [Analysis prompted by Results in Suppressed-Carrier Transmission: Possible Importance in I.F. Circuit Design in Superheterodyne Receivers].—D. M. Johnstone & E. E. Wright: G.W.O.H. (*Wireless Engineer*, Oct. 1936, Vol. 13, No. 157, pp. 534–536: Editorial pp. 517–518.)

87. An Anti-Fading Experiment [Reception on Two Broadcast Receivers tuned to Two Distant Stations sending Same Programme on Different Wavelengths].—(*World-Radio*, 23rd Oct. 1936, Vol. 23, p. 15.)

88. Central Radio Installations with High-Frequency Distribution (Central Aerial).—E. T. Glas. (*Teknisk Tidskrift*, 3rd Oct. 1936, Vol. 66, pp. 166–170: in Swedish.)

89. Valve Detector Circuit [Rectifying Action of Diode regulated by Voltage on Third Electrode: Applications to Fading Compensation, etc.]—Hewittic Company & Touly. (*Hochf:tech. u. Elek:akus.*, Sept. 1936, Vol. 48, No. 3, p. 109: French Pat. 798 934 of 5.4.1935.)

90. AFC [Automatic Frequency Control (Automatic Tuning Correction)] Design Considerations.—S. Y. White. (*Electronics*, Sept. 1936, Vol. 9, No. 9, pp. 28–29 and 31.) By the worker "whose January, 1935, paper in *Electronics* started the ball rolling."

91. Automatic Band-Width Regulation [Survey of Methods].—O. Köhler. (*Funktech. Monatshefte*, Sept. 1936, No. 9, pp. 337–344.) Based on damping by special parallel valve and by preceding amplifier valve; on detuning; on retroactive coupling variation; on inter-circuit coupling variation, using magnetic bias; etc.

92. The "Dual Control" [Volume Control by Mechanically Linked Input and Audio-Frequency Regulators] in Broadcast Receivers: the Determination of the Electrical Data.—G. Schrenk: Wechsung. (*Funktech. Monatshefte*, Sept. 1936, No. 9, pp. 352–356.) Following on Wechsung's paper (3409 of 1935). Provision has to be made for the device to afford complete volume control for gramophone working.

93. Is Volume Expansion Worth While?—J. Harmon. (*Wireless World*, 2nd Oct. 1936, Vol. 39, pp. 254–355.)

94. An Automatic Sensitivity Tuning System [specially suitable for Car Receivers, giving Audible and not Visual Tuning Indication].—A. W. Barber. (*Rad. Engineering*, Sept. 1936, Vol. 16, No. 9, pp. 19–20 and 29.) Suitable also for inexpensive receivers.

95. "Comment installer la T.S.F. dans les Automobiles" [Book Review]. — L. Chrétien. (*L'Onde Élec.*, Oct. 1936, Vol. 15, No. 178, p. 672.)

96. Notes on Police-Car Receivers [Outline of American Bosch Receiver].—S. E. Benson. (*Comm. & Broadcast Eng.*, Sept. 1936, Vol. 3, No. 9, p. 12.)

97. Mobile Receiving Equipment for the Illinois Police-Radio System.—C. A. Brokaw. (*Comm. & Broadcast Eng.*, Sept. 1936, Vol. 3, No. 9, pp. 5–7 and 20, 25.) *See* also 407, below.

98. New Progress in the Development of the 1600 kc/s Superhet ["Single-Span," German Version].—H. J. Wilhelmy. (*Funktech. Monatshefte*, Sept. 1936, No. 9, pp. 345–351.) For previous work *see* 1772 of 1936.

99. American Receivers: Averages of Prices, Power, etc.—Caldwell. (*World-Radio*, 23rd Oct. 1936, Vol. 23, p. 4.)

100. Negative Feed-Back Amplifiers, *and* The *Wireless World* Negative Feed-Back Amplifier.—W. T. Cocking. (*Wireless World*, 6th Nov. 1936, Vol. 39, pp. 475–478: 13th Nov. 1936, pp. 498–502.)

101. The *Wireless World* Pre-Tuned Quality Receiver [Four Stages: Straight R.F. Amplifier with Resistance-Coupled Push-Pull Amplifier].—W. T. Cocking. (*Wireless World*, 25th Sept. & 2nd Oct. 1936, Vol. 39, pp. 322–325 and 349–352.)

102. The Calculation of Shaped Cams [for Flexible-Wire Drives] for Broadcast Receivers.—R. Schadow. (*Funktech. Monatshefte*, Sept. 1936, No. 9, pp. 356–359.)

103. Notes on the Paris International Radio Exposition.—W. E. Kock. (*Electronics*, Aug. 1936, Vol. 9, No. 8, p. 40.)

"The most noticeable defect in all the sets displayed was the lack of fidelity. The bass was completely absent and highs above 4000 cycles were extremely weak. . . . The studio cables and studio equipment are such that high-quality reproduction as we know it is not obtainable even with high-fidelity receivers."

AERIALS AND AERIAL SYSTEMS

104. The Action of Single- and Multiple-Wire Reflectors.—O. H. Roth. (*Hochf:tech. u. Elek:akus.*, Aug. 1936, Vol. 48, No. 2, pp. 45–53.)

Theory and measurements of the field strength from a system of an emitter and one or several reflectors are given. The results are compared with those of Tatarinoff (*Jahrb. d. drahtl. Teleg. u. Teleph.*, Vol. 28, 1926, p. 117) and optimum distances between emitter and reflectors for field-strength values and for sharpness of directional characteristics are found. The aerial combination of Yagi (*Proc. Imp. Akad. Tokyo*, Vol. 2, 1926, p. 49) is investigated and the optimum reflector distances found. The change in wavelength of the system due to the coupling of the emitting aerial with the reflectors is also discussed.

105. The Radiation Properties of Small Parabolic Mirrors [for Micro-Waves] with Various Modes of Excitation: Parts I & II.—R. Brömel. (*Hochf:tech. u. Elek:akus.*, Sept. 1936, Vol. 48, No. 3, pp. 81–86: Oct. 1936, Vol. 48, No. 4, pp. 120–126.)

An experimental determination of the increase in field-strength and of the spatial radiation diagrams given by cylindrical and circular paraboloidal mirrors, with various arrangements of the emitting aerial at the focus of the paraboloid, and centimetre waves. Cylindrical mirrors are found to give a relatively small energy amplification even when the focusing properties are good; the amplification is improved when a reflecting dipole is present. Circular paraboloids are at most three times as effective as the cylindrical type. If the emitting dipole is directed along the axis of rotation of the paraboloid, the radiation is confined to a cone. Several coaxial cones are obtained when the aerial is excited in harmonics. Similar results are found for receiving mirrors.

106. Parallel Wires as R.F. Transformers [for Ultra-Short Waves used in Television: Practical Methods].—F. R. W. Strafford. (*Wireless World*, 2nd Oct. 1936, Vol. 39, pp. 346–348.)

107. Experiments with Television Aerials [Various Dipole Arrangements for Ultra-Short-Wave Reception, as regards Range and Reduction of Interference: Vertical Much Superior to Horizontal: etc].—F. R. W. Strafford. (*Wireless World*, 16th Oct. 1936, Vol. 39, pp. 394–396.)

108. Modified Sommerfeld's Integral and Its Applications [to Calculation of Radiation Resistances of Small Doublets and Small Loops inside Infinite Hollow Cylinder: also of Parallel Wires in Free Space].—S. A. Schelkunoff. (*Proc. Inst. Rad. Eng.*, Oct. 1936, Vol. 24, No. 10, pp. 1388–1398.)

109. On the Radiation Resistance of Tapered Wire Transmission Lines [with and without Bends: Theory and Experiment: Rapid Increase of Resistance with Angle between Wires: Calculations for Wires One-Half and One Wavelength Long: Decrease in Resistance with Certain Bending Conditions].—S. S. Banerjee & B. N. Singh. (*Phil. Mag.*, Nov. 1936, Series 7, Vol. 22, Supp. No. 150, pp. 955–967.) *See* also 1868 of 1935.

110. Characteristics of Transmission Lines at High Frequencies [Computations: Curves: Differential Time Delay and Attenuation in Air-Insulated Cables: Effects of Termination with Impedances differing from Line Surge Impedance].—T. Walmsley. (*Phil. Mag.*, Nov. 1936, Series 7, Vol. 22, Supp. No. 150, pp. 1048–1056.)

111. The Design of Doublet Antenna Systems [Double-Doublet for All-Wave Reception between 0.54 and 18 Mc/s: Balanced Operation at Higher Frequencies, Unbalanced at Lower: Coupling Filters, Transmission Line, etc.]—H. A. Wheeler & V. E. Whitman. (*Proc. Inst. Rad. Eng.*, Oct. 1936, Vol. 24, No. 10, pp. 1257–1275.) "The balanced operation of the horizontal doublet is unavoidably directive, but the directivity is substantially independent of frequency and is predetermined, so that it can be used to advantage." The other great advantage is the reduction of interference from near-by sources.

112. A Critical Study of Two Broadcasting Antennas [Double-Doublet (impracticable at present owing to Losses and Extremely Low Radiation Resistance when adjusted to give Good Anti-Fading Properties) and Loaded Quarter-Wave Aerial: Desirability of Investigation of Radiation Properties of Solid Contour Surfaces].—C. E. Smith. (*Proc. Inst. Rad. Eng.*, Oct. 1936, Vol. 24, No. 10, pp. 1329–1341.)

113. The Shunt-Excited Antenna.—Morrison & Smith. (*Bell Tel. System Tech. Pub.*, Monograph B–938, 24 pp.) The full paper, a summary of which was referred to in 2599 of 1936.

114. Developments in the Beam Array [British Association Paper].—A. W. Ladner. (*Engineering*, 30th Oct. & 6th Nov. 1936, Vol. 142, pp. 468 & 514–515.)

115. Earthing of High-Voltage Masts with Regard to Thunderstorm Effects [Requirements: Types of Earth for Iron and Cement Masts].—H. Grünewald & H. Zaduk. (*E.T.Z.*, 17th Sept. 1936, Vol. 57, No. 38, pp. 1079–1082: 24th Sept., No. 39, pp. 1108–1110.)

116. FORCES OF OBLIQUE WINDS ON TELEPHONE LINES.—J. A. Carr. (*Bell S. Tech. Journ.*, Oct. 1936, Vol. 15, No. 4, pp. 587–602.)

VALVES AND THERMIONICS

117. THE DEPTH AT WHICH SECONDARY ELECTRONS ARE LIBERATED.—H. Bruining. (*Physica*, Nov. 1936, Vol. 3, No. 9, pp. 1046–1052 : in English.)

The presence of a maximum in the secondary-emission/primary-velocity characteristic is usually attributed to the higher-velocity electrons liberating the secondary electrons at a greater depth, so that the latter suffer a greater absorption. If this is so, then the secondary emission should increase with increasing angle of incidence of the primaries ; but some workers have found that secondary emission is independent of the angle of incidence, although others (including Farnsworth) have found an increase with increasing angle. The present tests, with smooth and rough carbon targets, indicate that this discrepancy was probably due to differences in the smoothness of the surfaces employed. With rough surfaces the angle of incidence is not well-defined, and the curves for 0° and 60° show only a small difference in secondary emission. With smooth surfaces the increase with increasing angle is very marked, and the presence of a maximum on the characteristic can be explained as suggested, the ordinary absorption law being justifiably applied to the secondaries. The curve for 70° (the nearest approach to glancing incidence shown) seems to run almost horizontally after its bend, instead of descending markedly as it does for smaller angles. The mean depth of origin for the secondary electrons from a nickel target is estimated to be 30 Å below the surface for a primary energy of 500 v.

118. PAPERS ON SECONDARY-EMISSION ELECTRON MULTIPLIERS & IMAGE TRANSFORMERS.—Coeterier & Teves : Saic : Kubetski. (*See* 240/243.)

119. THE RECIPROCAL RELATION BETWEEN THE EMISSION OF SECONDARY ELECTRONS WITH PHOTOSENSITIVITY AND THE THERMO-ION EFFECT.—Dobrolyubski. (*See* 248.)

120. SIMPLE CIRCUIT PRECAUTIONS FOR IMPROVING THE PROPERTIES OF H.F. AMPLIFYING VALVES IN THE SHORT-WAVE RANGE.—M. J. O. Strutt & A. van der Ziel. (*E.N.T.*, Aug. 1936, Vol. 13, No. 8, pp. 260–268.)

The paper deals with pentodes ; for previous practical work *see* 1019 of 1936. The frequency variations of the valve impedances are considered theoretically (§ 2) ; it is found that any admittance may be regarded as a circuit with R and C in parallel, where $1/R$ and C are each developable as power series in ascending powers of the square of the frequency. This is extended to the introduction of new circuit elements. The input, output and reaction admittances and the steepness of the characteristics of a pentode are worked out (§ 3) when an impedance is introduced into the cathode lead. Theory and measurements of the input and anode impedances are further discussed in §§ 4, 5 ; § 6 deals with reaction impedance, which may be increased by introducing an additional capacity or mutual inductance.

121. ELECTRON BEAMS AND THEIR APPLICATIONS IN LOW-VOLTAGE DEVICES.—H. C. Thompson. (*Proc. Inst. Rad. Eng.*, Oct. 1936, Vol. 24, No. 10, pp. 1276–1297.) *See* also 3045 of 1935. " The relationships between beam widths and electrode potentials have been found to be such that mutual volt/ampere relations can be radically different from those hitherto utilised. Linear, saturation type, or special volt/ampere relations can be obtained. . . ."

122. AN ALL-STAGE VALVE.—J. H. O. Harries. (*Wireless World*, 20th Nov. 1936, Vol. 39, p. 559.) A new type of valve which is to appear shortly.

123. A SIMPLIFIED HARMONIC ANALYSIS [5 . . . 13-Point Analysis by Ordinates erected at *Selected* Points along Voltage Axis].—E. L. Chaffee. (*Review Scient. Instr.*, Oct. 1936, Vol. 7, No. 10, pp. 384–389.) Developed primarily for valve problems. The selected ordinates correspond to certain values of C ($= \cos \omega t = e/E_m$) which yield simple equations.

124. GRID LOSS AT ULTRA-HIGH FREQUENCIES [and the Difficulties in Reception : Advantages of the " Acorn "-Type Valve Construction : etc.], *and* " ACORNS " AND THEIR APPLICATIONS.—M. G. Scroggie. (*Wireless World*, 23rd Oct. 1936, Vol. 39, pp. 424–427 : 20th Nov. 1936, pp. 522–524.)

125. THE GLOW DISCHARGE AT LOW PRESSURES BETWEEN COAXIAL CYLINDERS IN AN AXIAL MAGNETIC FIELD.—F. M. Penning. (*Physica*, Nov. 1936, Vol. 3, No. 9, pp. 873–894 : in German, with long English summary.)

Tests with argon down to about 3×10^{-5} mm : also helium. Field acts as apparent increase of gas pressure, decreasing the striking potential and greatly increasing the current density (*e.g.* 10^4 times). Effect of inclination of cathode to magnetic field is sometimes to increase, sometimes to decrease, the striking potential. Effect of inhomogeneity of field, explained by the form of the electron paths. Effect of roughness of cathode surface. Possibility of use of tube as a rectifier.

126. THE DEVELOPMENT OF LARGE RADIO TRANSMITTING VALVES [M.O. Valve Company's Research Work].—Le Rossignol & Hall. (*Marconi Review*, July/Aug. 1936, No. 61, pp. 6–29.)

127. PUSH-PULL POWER PENTODE IN COMMON ENVELOPE, WITH INTERCONNECTED SCREEN AND SUPPRESSOR GRIDS, PROVISION FOR COOLING ALL GRIDS AND COMPLETE SHIELDING BETWEEN INPUT AND OUTPUT CIRCUITS : FOR ULTRA-SHORT-WAVE TELEVISION.—Samuel & Sowers. (*Sci. News Letter*, 17th Oct. 1936, Vol. 30, p. 249.) For the full paper, " A Power Amplifier for U-H Frequencies " see *Proc. I.R.E.*, Nov. 1936, pp. 1464–1483.

128. MODERN ELECTRON RECEIVING VALVES WITH MULTIPLE ELECTRODES [General Description: Tendencies].—M. Adam. (*Rev. Gén. de l'Élec.*, 3rd Oct. 1936, Vol. 40, No. 14, pp. 443–456.)

129. THE *Wireless World* VALVE DATA SUPPLEMENT. —(*Wireless World*, 20th Nov. 1936, Vol. 39, pp. 533–555.)

130. SUPPLEMENT TO THE VALVE TABLES IN THE MAY AND NOVEMBER, 1935, NUMBERS.—Decaux. (*L'Onde Élec.*, Nov. 1936, Vol. 15, No. 179, pp. 740–753.)

131. THE NEW WIRELESS RECEIVING VALVES [as seen at the Paris Salon].—(*Génie Civil*, 10th Oct. 1936, Vol. 109, pp. 311–312.)

132. AMPLIFIER CIRCUITS WITH THE NEW OUTPUT TRIODE AD1 [4 Watts Output, 3–4% Distortion: or Push-Pull 10 Watts, 1% Distortion].—H. Hertel. (*Funktech. Monatshefte*, Sept. 1936, No. 9, pp. 333–336.)

133. AMATEUR APPLICATIONS OF THE "MAGIC EYE": USING THE 6E5 [Fluorescent-Screen] VALVE AS A VALVE VOLTMETER, MODULATION METER, ETC.—L. C. Waller. (*QST*, Oct. & Nov. 1936, Vol. 20, Nos. 10 and 11, pp. 35–39 & 23–26 and 33.)

134. A NEW METHOD FOR INVESTIGATING CONDUCTION PHENOMENA IN SEMICONDUCTORS [Langmuir Probe Method with Tungsten Wire coated with Insulating Material: Electron Diffusion through Alumina].—J. A. V. Fairbrother. (*Proc. Roy. Soc.*, Series A, 1st Oct. 1936, Vol. 157, No. 890, pp. 50–66.) Work with bearing on experiments of Reimann & Treloar (1932 Abstracts, pp. 96–97) on emission from oxide-coated cathodes.

135. VARIATION OF FIELD ELECTRON EMISSION WITH WORK FUNCTION [Measurements with Ba, Mg, Cs Films on Tungsten Base: Disagreement with Theory of Tunnel Effect: Potential Threshold corresponding to Work Function is not Overstepped].—E. W. Müller. (*Zeitschr. f. Physik*, No. 11/12, Vol. 102, 1936, pp. 734–761.)

136. AN INVESTIGATION OF IRREGULARITIES IN THERMIONIC EMISSION FROM TUNGSTEN.—F. L. Yerzley. (*Phys. Review*, 1st Oct. 1936, Series 2, Vol. 50, No. 7, pp. 610–616.)

Author's summary:—A tube employing a moving electrode is used to investigate variations in emission density over the length of a straight tungsten filament. After a critical temperature range is exceeded, positive ion emission is shown to be limited to narrow regions near the lead-wire connections. Electron emission, even after the filament is carefully aged, is not uniform from point to point, but occurs in a stable though irregular pattern. The irregularity is attributed to differences in work function or to differences in actual area covered by the slit, or to a combination of both.

137. POSITIVE AND NEGATIVE THERMIONIC EMISSION FROM TUNGSTEN [Measurements: Emissivity: Heat of Evaporation of Neutral Atoms: Electron Work Function: Average Positive Ion Work Function].—H. B. Wahlin & L. V. Whitney. (*Phys. Review*, 15th Oct. 1936, Series 2, Vol. 50, No. 8, pp. 735–738.)

DIRECTIONAL WIRELESS

138. ON THE DESIGN OF EQUI-SIGNAL RADIO BEACONS WITH OVERLAPPING SIGNALS, FOR CIVIL AIR ROUTES.—N. A. Myasoedov. (*Isvestiya Elektroprom. Slab. Toka*, No. 8/9, 1936, pp. 1–18.)

For previous work *see* 1811 & 2598 of 1936. A long air route usually consists of a series of straight lines connecting the airports located on the route. A radio beacon installed at one of the intermediate airports would, therefore, be required to radiate signals in two directions, normally at an angle to each other. In the present paper a study is made of three beacon systems, a, b and c, with the following characteristics: (a) two closed aerials giving two sinusoidal polar curves of different intensities; (b) two closed and one open aerial giving two identical Pascal limaçon (spiral) polar curves (eqn. 12); and (c) one closed and one open aerial giving two Pascal limaçon polar curves of different intensities (eqn. 25a). For each of these systems formulae are derived determining the polar diagrams and their relative positions for a given beam width and a given angle between the two directions; the "power efficiency" is also determined, *i.e.*, the ratio of the aerial power required for a given range when only one closed aerial is used to the aerial power when two-direction radiation is employed.

A detailed comparison of the three systems is given and the paper is concluded by a numerical example.

139. RADIO EQUIPMENT AT THE BROMMA AERODROME [including the Ultra-Short-Wave Guiding Beam with Alternate Keying of Passive Side Dipoles].—T. Elmquist. (*Teknisk Tidskrift*, 7th Nov. 1936, Vol. 66, No. 45, Supp. pp. 173–175: in Swedish.) For this beam system *see* 1934 Abstracts, p. 42 (Lorenz Company).

140. BLIND LANDING METHOD FOR AIRCRAFT [Measurement of Height by Measuring Distance and Angle of Elevation from Known Points by Combination of Signals from Those Points].—Soc. Française Radio-Électrique. (*Hochf:tech. u. Elek:akus.*, Sept. 1936, Vol. 48, No. 3, pp. 109–110: French Pat. 799 180 of 9.3. 1935.)

141. INTERFERENCE PHENOMENA BETWEEN WAVES OF PERIODICALLY VARIABLE FREQUENCY: ELECTRICAL AND ACOUSTIC APPLICATIONS [including Distance Determination].—Brillouin. (*See* 143.)

142. Directional Arrangement with Two Similar, Separately Tuned Receiving Aerials [Tuning with Auxiliary Emitter in Symmetrical Position: Tuning tested by passing Received Signals through Intermediate Circuit in Opposite Directions, when they Cancel].—W. Runge: Telefunken. (*Hochf:tech. u. Elek:akus.*, Sept. 1936, Vol. 48, No. 3, p. 109: German Pat. 628 763 of 16.2.1934.)

ACOUSTICS AND AUDIO-FREQUENCIES

143. Interference Phenomena between Waves of Periodically Variable Frequency. Electrical and Acoustic Applications [Analytical Study of Beats: Mean Values of Power: Application to Problems of Sounding and Signals: Space between Two Sources divided into Zones by Power Maxima: Possibility of deducing Distance of Ship or Aeroplane from Emitter: Principles of Application to Measurement of Acoustic Properties of Reverberating Spaces].—J. Brillouin. (*Rev. Gén. de l'Élec.*, 3rd Oct. 1936, Vol. 40, No. 14, pp. 434–441.)

144. High-Speed Counting of Auditory Stimuli [*e.g.* in Beat-Method Frequency Measurements: Counting Rate extended to 12 per Second by Psychological Artifice].—Hunt. (*Review Scient. Instr.*, Nov. 1936, Vol. 7, No. 11, p. 437.)

145. Reverberation Effects in Closed Spaces: Their Measurement and Reproduction. —Bürck, Kotowski & Lichte. (*E.N.T.*, Aug. 1936, Vol. 13, No. 8, pp. 268–279.)

See also 1472 of 1936. It is here shown, theoretically and experimentally, that a closed space in which reverberation occurs may be regarded as a system of very weakly coupled oscillating circuits of given decrements. All observed phenomena may thereby be explained and reproduced by means of electric circuits. Illustrative oscillograms are shown. Methods of reverberation measurement are discussed.

146. A New Apparatus for Reverberation Measurements [Acoustic Oscillations passed through Microphone to Apparatus for measuring Depth of Modulation: Smallest Measurable Reverberation Time approximates to Modulation Period].—F. Benz. (*Hochf:tech. u. Elek:akus.*, Sept. 1936, Vol. 48, No. 3, pp. 98–99.)

147. Air Conditioning of Broadcasting Studios [with Particular Reference to India].—V. Balasubramanyan. (*Electrotechnics*, Bangalore, April, 1936, No. 9, pp. 84–88.)

148. Sound-Insulating Materials: Lead, an Important Auxiliary in the Fight against Noise.—J. Mahul. (*Génie Civil*, 17th Oct. 1936, Vol. 109, pp. 329–331.)

149. Acoustical Terms and Definitions: the British Standard Glossary and Its Bearing on Industrial Noise Problems. —B. H. Churcher. (*World Power*, Oct. 1936, Vol. 26, pp. 96–98.)

150. Electrical Methods of Measuring Sounds and Noises [General Description of Modern Methods and Apparatus].—T. Kahan. (*Rev. Gén. de l'Élec.*, 24th Oct. 1936, Vol. 40, No. 17, pp. 523–534.)

151. Reduction of Airplane Noise and Vibration.—Spain, Loye & Templin. (*Bell S. Tech. Journ.*, Oct. 1936, Vol. 15, No. 3, pp. 626–627: summary only.)

152. Noise Phenomena in the Conversion of Electrical Energy [with Examples of Audio-Frequency Spectra of Switches, Machines, etc.].—E. Lübcke. (*Siemens-Zeitung*, Vol. 16, 1936, p. 204: abstract in *E.T.Z.*, 22nd Oct. 1936, Vol. 57, No. 43, pp. 1239–1240.)

153. Velotron Microphone [Velocity Type employing Static Field and giving Output around −53 db, much higher than Conventional Magnetic Velocity Type].—Bruno Laboratories. (*Electronics*, Aug. 1936, Vol. 9, No. 8, p. 54.) Also *ibid.*, Sept. 1936, pp. 21–22.

154. The Analysis of the Audio-Frequency Circuit for connecting a Condenser Microphone [and a Discussion of Jakovlev's Method].—P. V. Stender. (*Izvestiya Elektroprom. Slab. Toka*, No. 8/9, 1936, pp. 29–31.) For Jakovlev's method *see* 1928 Abstracts, p. 398.

155. Transient Processes in Microphones.— S. Barta. (*Karlsruhe Dissertation*, 1934: 102 pp: in German: pub. by Gyori Hirlap, Gyor. 7042, Budapest.)

Introduction: the Wente condenser microphone and its calibration: investigations of Riegger, ribbon & other types as regards transients: relation between damping and behaviour to transients, including the deduction of the transient period from frequency curves, by an approximation method.

156. Remarks on Proposal for Testing Microphones.—H. J. von Braunmühl. (*E.N.T.*, Aug. 1936, Vol. 13, No. 8, pp. 281–282.) For the proposal *see* 3831 of 1936.

157. Mixing Circuits [for Several Pick-Ups and Microphones in P.A. Systems: Separate Input Valve for Each Channel is the Only Satisfactory Method].—W. T. Cocking. (*Wireless World*, 9th Oct. 1936, Vol. 39, pp. 376–380.)

158. Characteristics of Cone-Type Dynamic Loudspeakers and Their Design Precautions: Parts I & II.—H. Wada. (*Nippon Elec. Comm. Engineering*, Sept. 1936, No. 4, pp. 363–365: summary only, in English.) A summary of Part I was referred to in 3054 of 1936.

159. The Appraisement of Loudspeakers: Part I [Imperfections (of Domestic and Public Entertainment Types) and Their Measurement].—F. H. Brittain. (*G.E.C. Journ.*, Nov. 1936, Vol. 7, No. 4, pp. 266–276.)

"No system of appraising the results in the light of listening experience has been suggested. This will be done in the second section dealing with the general term 'Audition'."

160. Reproduction of Transients by a Cone Loudspeaker [Theory].—N. W. McLachlan & A. T. McKay. (*E.N.T.*, Aug. 1936, Vol. 13, No. 8, pp. 251–259.)

"The theory of transient phenomena in dynamic loudspeakers with and without a cone is developed with the aid of Heaviside operators and curvilinear integrals. Numerical results are given for the sound-pressure output from a cone loudspeaker resulting from an impressed e.m.f. of the form $e^{-at} \sin \omega t$." The effect of the membrane oscillations is considered. For "Transient Oscillations in a Loudspeaker Horn," by the same writers, *see* 3053 of 1936.

161. The Piezoelectric Properties of Rochelle Salt [Corrections to Previous Paper: Verification of Mueller's Theory].—O. Norgorden. (*Phys. Review*, 15th Oct. 1936, Series 2, Vol. 50, No. 8, p. 782.) For the paper and theory in question *see* 3441 of 1936 and 1483 of 1935.

162. Beautiful Baffles! [Acoustic Advantages of "Irregular" Baffles, especially of Those based on Common Spiral: Suggested "Heart-Shape" Design].—D. W. Ashworth. (*Wireless World*, 6th Nov. 1936, Vol. 39, p. 479.)

163. Recent Progress in the Acoustics of Sound Recording and Reproduction for Motion Pictures.—F. L. Hunt. (*Review Scient. Instr.*, Sept. 1936, Vol. 7, No. 9, pp. 323–328.)

164. Experiments in Home Recording.—R. W. Bradford. (*Wireless World*, 25th Sept. 1936, Vol. 39, pp. 326–328.)

165. What can be done about This? [Public Demand for Recording Device for Broadcast Receivers].—(*Rad. Engineering*, Sept. 1936, Vol. 16, No. 9, pp. 41 & 43.)

166. Inverse-Feedback Circuits for A.F. Amplifiers.—RCA Radiotron. (*Rad. Engineering*, Sept. 1936, Vol. 16, No. 9, pp. 11–13.)

167. A 6L6 Amplifier [Beam Power Valves in Degenerative Amplifier Circuit to provide High Power Output, Variable Frequency-Compensation, and Low Harmonic Distortion].—L. Oxman. (*Electronics*, Sept. 1936, Vol. 9, No. 9, pp. 30–31.) To give the full 20-watts power necessary (in a large living room) for such high-fidelity reproduction as that of the Philadelphia/Washington experiments. Actually, 60 watts can be obtained if desired (but *cf.* 168, below.)

168. The 6L6 [Beam Power Valve] and High-Fidelity Equipment.—I. A. Mitchell. (*Comm. & Broadcast Eng.*, Sept. 1936, Vol. 3, No. 9, pp. 17–19.)

Two of these valves in self-bias Class AB 1 are rated to deliver 32 w: operating with fixed bias or Class AB 2, to deliver 60 w. But to get the 60 w at low harmonic distortion involves a greater cost than to use 4 valves in push-pull parallel Class AB 1, and loses the appreciably longer valve-life, and reduction of high-power transients, given by self-bias operation. The amplifier here described uses the former system, combined with a simple and stable form of negative feed-back (from tertiary windings on the output transformer) which causes a 10% degeneration and reduces the power sensitivity by 55%, the harmonic distortion by about 50%, and the dynamic plate resistance (the highness of which has hitherto somewhat hindered the use of these valves for high-fidelity purposes) by 85%.

169. Balanced Amplifiers. Part III—Analysis [assuming McLaurin Series: Deductions regarding Effects of Mid-Branch Impedance and Voltages: Ideal Push-Pull Valves].—A. Preisman. (*Comm. & Broadcast Eng.*, Sept. 1936, Vol. 3, No. 9, pp. 13–16 and 19.)

170. A Direct-Coupled 3-Watt Amplifier for A.C. Mains [Screen-Grid Valve, Pentode Output, and Rectifier: Almost Flat Characteristic 20–10 000 c/s: New Type of Volume Control by Rotary Potentiometer as First-Stage Anode Resistance, with Slider earthed through 2 Microfarad Condenser].—L. W. Herterich & H. J. Wilhelmy. (*Funktech. Monatshefte*, Oct. 1936, No. 10, pp. 387–391.)

171. Resistance-Coupled Amplifiers [for High-Quality Reproduction: Fundamental Principles and Practical Considerations].—W. T. Cocking. (*Wireless World*, 30th Oct. & 6th & 13th Nov. 1936, Vol. 39, pp. 466–467, 490–492, & 517–518.)

172. Reactors in D.C. Service [Design Calculation Methods for Iron-Cored Audio-Frequency Reactors (Large or Small) in terms of the Steady D.C. Current carried].—R. Lee. (*Electronics*, Sept. 1936, Vol. 9, No. 9, pp. 18–20 and 76.) Based on Hanna's 1927 work.

173. The Operation of a Variable Oscillator for Speech Frequencies with an Iron-Cored Choke [Dynatron Oscillator with Variable Condenser, shunted by Choke, in Tuned Anode Circuit: Nearly 4:1 Frequency Variation for Fixed Value of Condenser, by Grid-Bias Regulation].—E. W. Marchant. (*Engineering*, 23rd Oct. 1936, Vol. 142, p. 457.) British Association paper.

174. A Single-Pentode Beat-Frequency Oscillator using a Dynatron Circuit on the Third Grid.—S. Takamura. (*Nippon Elec. Comm. Engineering*, Sept. 1936, No. 4, pp. 347–355: in English.) An abstract was referred to in 3074 of 1936. The dynatron and back-coupled oscillations are mixed, by electron-coupling action, to give the beat frequency.

175. Thyratron-Operated Wave Generator [Relaxation Circuit exciting H.F. Oscillatory Circuit, yielding Damped Wave-Trains at Any Required Audio-Frequency].—C. V. Rajam. (*Journ. Scient. Instr.*, Oct. 1936, Vol. 13, No. 10, pp. 331–333.) One obvious use is to replace the ordinary buzzer circuit : the new device is always reliable and makes no noise. It can be operated by battery or mains.

176. The Use of the Type CO-183 Valve in Heterodyne Oscillators.—M. A. Merkul'ev. (*Izvestiya Elektroprom. Slab. Toka*, No. 89, 1936, pp. 36–38.) A heterodyne oscillator for testing purposes normally consists of two oscillators and a detector. A report is here presented on experiments carried out with a single multi-electrode valve, in place of the detector and one of the oscillators.

177. Experiments on Amplitude Limiters for Telephone Connections.—F. Strecker. (*E.N.T.*, Oct. 1936, Vol. 13, No. 10, pp. 341–357.)

Some simple circuits for amplitude limitation are given ; experiments are described on the variation, with the degree of limitation, of attenuation of a sinusoidal current, relative attenuation of speech, comprehensibility of syllables, and " klirr " factor. Illustrative oscillograms are given. Possible practical applications are discussed ; the experiments and discussions are stated to be of a preliminary character throughout.

178. Progressive Waves of Finite Amplitude and Some Steady Motions of an Elastic Fluid.—H. Bateman. (*Proc. Nat. Acad. Sci.*, Oct. 1936, Vol. 22, No. 10, pp. 607–619.)

179. Method of Measurement of Threshold Pressures and Ear-Drum Impedances in Progressive Waves.—L. Keibs. (*Ann. der Physik*, Series 5, No. 7, Vol. 26, 1936, pp. 585–608.)

For previous work *see* 3065 of 1956. Measurement of ear-drum impedance and threshold values involves measurement of the energy impinging on the ear and of the absorption coefficient of the ear-drum. The acoustic field at the end of a long tube with a known source at the other end can be calculated and regulated by altering the length of the tube ; the method here described is developed with this as basis. The theory and formulae for the energy are worked out and measurements are tabulated. The arrangement for measuring the impedance is shown in Fig. 6. The pressure at the end of the tube is measured when the tube is closed (a) by the ear-drum, (b) by a rigid stop. Formulae for the value of the impedance are worked out and typical measurements given.

180. The Social Implications of Scientific Research in Electrical Communication [including Dudley's Recent Results on the Synthesis of Speech from Two " Noises "].—F. B. Jewett : Dudley. (*Scient. Monthly*, Nov. 1936, pp. 466–476.)

181. On the Persistence of the Sensation of Speech [and the Possibility of Simultaneous Transmission and Reception].—M. Marro. (*Phil. Mag.*, Nov. 1936, Series 7, Vol. 22, No. 149, pp. 847–854.)

See also 2235 of 1936. Considerations of the principle of persistence of sensation of speech, analogous to that of vision, lead the writer to the conception of the possibility of simultaneous wireless transmission and reception by the use of apparatus (*e.g.*, a rotating drum commutator, experiments with which are described) for the periodical interruption of speech. Experiments on the relation between the continuity of transmitted speech and the frequency of interruption are described ; " it appears that a band of interruptions extending from 35 to 50 per second creates the illusion of continuity of speech without prejudice to its characteristic tone." *Cf.* Antoun & Minaw, 182, below.

182. Simultaneous Transmission and Reception of Radio Waves.—H. Antoun & F. Minaw. (*Nature*, 31st Oct. 1936, Vol. 138, p. 761 : *Physik. Zeitschr.*, 1st Oct. 1936, Vol. 37, No. 19, p. 695.)

The writers employ simultaneous modulation of a short-wave valve receiver and transmitter to emit signals and receive those from another station with the same aerial at the same time. The modulating wave-form is shown ; it is of saw-tooth form with gaps between the teeth. The intermittent wave-trains emitted under various conditions are also shown. [It is not stated whether the device is used for telegraphy or telephony ; the modulation method used is not indicated, nor is it made clear whether the incoming signals are received during the gaps in the transmission.]

183. Speech Investigations with Filters and a 7-Loop Oscillograph.—Trendelenburg & Franz. (*E.T.Z.*, 12th Nov. 1936, Vol. 57, No. 46, p. 1324 : summary only.)

184. " Psychology of the Vibrato in Voice and Instrument " [Book Review].—C. E. Seashore. (*Review Scient. Instr.*, Oct. 1936, Vol. 7, No. 10, p. 372.)

185. On the Theory of Violin Strings.—A. A. Witt. (*Journ. of Tech. Phys.* [in Russian], No. 9, Vol. 6, 1936, pp. 1459–1479.)

186. The Acoustics of Musical Pipes.—K. V. Struve. (*Journ. of Tech. Phys.* [in Russian], No. 8, Vol. 6, 1936, pp. 1363–1373.) Methods are indicated for calculating the fundamental frequencies and frequency characteristics of wood and brass wind instruments of any complexity ; the theoretical results obtained are illustrated by a number of examples.

187. Broadcasting of Musical Standard Pitch [Data of Test Radio Broadcast of 440 c/s].—Nat. Bureau of Standard Notes. (*Journ. Franklin Inst.*, Sept. 1936, Vol. 222, No. 3, p. 365.)

188. The Internal Friction of Solid Bodies; Absorption Frequencies of Metals in the Acoustic Range [Theory: Experimental Determination of Decrement below 500 c/s].—K. Bennewitz & H. Rötger. (*Physik. Zeitschr.*, 15th Aug. 1936, Vol. 37, No. 16, pp. 578–588.)

189. Supersonic Stroboscopes [with Standing Waves in Solids and Liquids].—E. Hiedemann & K. H. Hoesch. (*Zeitschr. f. Physik*, No. 3/4, Vol. 102, 1936, pp. 253–258.)

Two kinds of supersonic stroboscopes are distinguished, those using voltage-optical effects and those employing modulation of the light intensity. Their applicability is illustrated by photographs of progressive supersonic waves. A simple method is described for measuring the duration of illumination in the different stroboscopes by photographing the supersonic field in front of an oblique reflector.

190. Acoustic Dispersion in Liquids [Acoustic Velocities measured by Visible Standing Supersonic Waves: Data for Various Organic Liquids at Different Frequencies].—Hiedemann, Seifen & Schreuer. (*Naturwiss.*, 23rd Oct. 1936, Vol. 24, No. 43, p. 681.)

191. On the Theory of Sound Dispersion.—Landau & Teller. (*Physik. Zeitschr. der Sowjetunion*, No. 1, Vol. 10, 1936, pp. 34–43: in German.)

192. The Absorption of Elastic Waves in Fluids [Theory: Density Variations may cause Notable Increase in Absorption Coefficient].—R. Lucas. (*Comptes Rendus*, 24th Aug. 1936, Vol. 203, No. 8, pp. 459–461.) *See* also 645 & 2251 of 1936, and 193, below.

193. The Diffusion of Elastic Waves in Fluids [Theoretical Relations giving Extinction Coefficient of Supersonic Waves].—R. Lucas. (*Comptes Rendus*, 5th Oct. 1936, Vol. 203, No. 14, pp. 611–613.) *See* also 192.

194. The Temperature Variation of the Absorption Coefficient of Supersonic Waves in Liquids [Measurements on Organic Liquids and Water].—C. Sörensen. (*Ann. der Physik*, Series 5, No. 1, Vol. 27, 1936, pp. 70–74.) For previous work, giving method, *see* 3084 of 1936.

195. The Compressibility of Electrolytic Solutions [determined from Measurements of Velocity of Sound by Optical Effect of Supersonic Standing-Wave System].—C. Bachem. (*Zeitschr. f. Physik*, No. 9/10, Vol. 101, 1936, pp. 541–577.)

196. Contribution to the Study of the Debye-Sears Effect [Measurements of Distribution of Luminous Intensity in Diffraction Spectra of Supersonic Wave Lattice: Effect of Variation of Voltage applied to Piezoelectric Quartz Emitter].—Hrdlička, Valouch & Zachoval. (*Comptes Rendus*, 26th Oct. 1936, Vol. 203, No. 17, pp. 786–787.)

197. Photometric Investigations of the Diffraction of Light by Supersonic Waves in Liquids and Gases [Photographic/Photometric Measurements of Ratio of Intensities of Zero and First Order Diffraction Spectra: Agreement with Theory: Variation with Angle between Incident Light and Acoustic Wavefront, Length of Light Path in Acoustic Field, and Wavelength of Light].—W. Korff. (*Physik. Zeitschr.*, 15th Oct. 1936, Vol. 37, No. 20, pp. 708–720.)

198. Diffraction of Light by Ultrasonic Waves [Remarks on Theory].—C. V. Raman & N. S. Nagendra Nath. (*Nature*, 10th Oct. 1936, Vol. 138, p. 616.)

199. Current, Breakdown, and Supersonic Waves in Dielectric Liquids.—Meyer. (*See* 364.)

200. The Problem of the Propagation of Sound in Partially Dissociated Gases [Theoretical Discussion of Measurements in N_2O_4].—H. O. Kneser & O. Gauler. (*Physik. Zeitschr.*, 1st Oct. 1936, Vol. 37, No. 19, pp. 677–684.)

201. The Determination of the Specific Heat of Gases at High Temperatures by the Sound Velocity Method. II—Carbon Dioxide.—Sherratt & Griffiths. (*Proc. Roy. Soc.*, Series A, 1st Sept. 1936, Vol. 156, No. 889, pp. 504–517.) For I *see* 788 of 1935.

202. Echo-Sounders: Their Use for the Detection of Fish [and Some Recent Results].—(*Electrician*, 30th Oct. 1936, Vol. 117, p. 522.) *See* also 3124 of 1935.

203. Vibrations of a Liquid Membrane exposed to High-Frequency Sound Waves [Granulation Phenomena in Soap Film].—J. Hartmann & P. von Mathes. (*Phil. Mag.*, Nov. 1936, Series 7, Vol. 22, Supp. No. 150, pp. 883–891.)

204. Notes on High-Intensity Sound Waves [including the Extinction of Discharges].—C. G. Suits. (*Gen. Elec. Review*, Sept. 1936, Vol. 39, No. 9, pp. 430–434.)

205. The Hartmann Acoustic [Air-Jet] Generator.—Hartmann. (*Engineering*, 6th Nov. 1936, Vol. 142, pp. 491–492.) *See* also 2259 of 1936.

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206. Address to Television Society: General Problems of Television.—N. Ashbridge. (*Journ. Television Soc.*, June, 1936, Series 2, Vol. 2, Part 5, pp. 125–128.)

207. Discussion on the Future of High-Definition Television.—(*Journ. Television Soc.*, June, 1936, Series 2, Vol. 2, Part 5, pp. 132–137.)

208. The Mental Effects of Television : What Television offers Us Today.—Pear. (*The Listener*, 11th Nov. 1936, Vol. 16, p. 888.) Continued from preceding issue : to be concluded.

209. "Television Technical Terms and Definitions" [Book Reviews].—E. J. G. Lewis. (*Journ. Television Soc.*, June, 1936, Series 2, Vol. 2, Part 5, p. 179 : *Wireless Engineer*, Dec. 1936, Vol. 13, No. 159, p. 636.)

210. Ultra-Short-Wave Service Area [Alexandra Palace Television Transmissions : Field Strengths judged by Background Noise, on Journey to Tonbridge (32 Miles) : Effect of Hills : Results in Other Directions].—M. G. Scroggie. (*Wireless World*, 9th Oct. 1936, Vol. 39, pp. 370–372.) The suspicion that overhead wires had been helping reception was dispelled by tests along roads devoid of such wires.

211. The London Television Station, Alexandra Palace : Technical Details of the Baird Equipment : of the Marconi-E.M.I. Equipment.—(*Journ. Television Soc.*, June, 1936, Series 2, Vol. 2, Part 5, pp. 156–160 : 161–168 : 169–176.) *See* also *Electrician*, 2nd and 9th Oct. 1936, Vol. 117, pp. 403–405 and 431–432.

212. Television Receivers : Work of the G.E.C. Research Laboratories.—(*Electrician*, 11th Sept. 1936, Vol. 117, pp. 311–313.)

213. Television in America [Philco and Farnsworth Systems].—(*Wireless World*, 23rd Oct. 1936, Vol. 39, pp. 429–431.)

214. Philco's Television System [as transmitted from W3XE].—Philco Corporation. (*Comm. & Broadcast Eng.*, Sept. 1936, Vol. 3, No. 9, p. 23.) "When the upper limit of the modulation band is pushed to 2.4 Mc/s the problem of constructing amplifiers and modulators becomes a difficult task. The solution was the invention of a new type of modulation which is being used in the system." *See* also *Rad. Engineering*, Sept. 1936, Vol. 16, No. 9, pp. 9–10.

215. The Farnsworth Television Receiver [with Circuit Diagram].—(*Rad. Engineering*, Sept. 1936, Vol. 16, No. 9, pp. 14–15.) *See* also *Comm. & Broadcast Eng.*, Sept. 1936, Vol. 3, No. 9, pp. 10–11.

216. Television fails to reach Home-Movie Standard [Note on RCA Demonstration].—(*Journ. Television Soc.*, June, 1936, Series 2, Vol. 2, Part 5, pp. 179–180.)

217. The Television Exhibits at the 1936 Berlin Exhibition.—G. Kette. (*Funktech. Monatshefte*, Sept. & Oct. 1936, Nos. 9 & 10, Supp. pp. 65–68 & 73–80.)

218. Television at the Olympic Games and at the Berlin Wireless Exhibition.—(*L'Onde Élec.*, Nov. 1936, Vol. 15, No. 179, pp. 729–739.)

219. A Simplified Television Receiver ["Visiodyne Baby"].—P. Besson : Chauvierre. (*L'Onde Élec.*, Oct. 1936, Vol. 15, No. 178, pp. 659–671.) Using only one octode frequency-changer, two i.f. pentodes, one duo-diode (detection and l.f. amplification), one line thyratron and one frame thyratron, and a Philips oscillograph tube ; together with one rectifier for the valves and one for the cathode-ray tube.

220. Remark on Intermediate-Frequency Wide-Band Amplifiers ["Damped Resonance" Type as used in the "Visiodyne" Receiver].—M. Chauvierre. (*L'Onde Élec.*, Oct. 1936, Vol. 15, No. 178, pp. 645–649.)

Author's summary :—The author studies briefly the conditions of employment, for television, of damped-resonance amplifiers [adopted, in the "Visiodyne," in preference to the aperiodic type for various reasons, including the possibility of correcting a high-frequency deficiency], and shows that for a given degree of selectivity it is impossible to increase the amplification indefinitely by increasing the number of stages. He gives some values of the coefficient Q of the quality of the circuits actually realised in practice ["For a single circuit, to obtain a 10% attentuation at 200 kc from the resonance frequency the circuit resistance must approach 60 ohms, corresponding to a Q of 10 and an impedance of the order of 5000 ohms. With two circuits forming a stage, to preserve the same selectivity R must be about 90 ohms, making Q about 3.3 and Z about 3000 ohms. Thus we are far from the circuits used in radiotelephony"]. He considers, however, that with very steep-slope valves it is possible, in this very simple way, to obtain results satisfactory for television [the 10% loss at 200 kc from resonance "is sufficiently good, for . . . l.f. correction can be applied and, better still, the non-linearity of the i.f. amplifier can be used—provided the effect is not carried too far—to correct the lack of high frequencies by a systematic detuning"]. He also shows that the employment of over-coupled resonant circuits [circuits with coupling exceeding the optimum value, as proposed by "foreign technicians" for use as so-called "band filters"] does not lead to very good results, particularly as regards amplification. In such cases complex systems [mixed linking by over-coupled circuits and direct couplings, with systematic detuning], ought to be employed [but for a satisfactory compromise between quality and cost, the damped-resonance system with steep-slope valves appears to be the logical solution].

221. Reproduction of Transients by Television Amplifiers [Results of Analysis of the C. H. Smith and von Ardenne Circuits].—N. W. McLachlan. (*Wireless Engineer*, Oct. 1936, Vol. 13, No. 157, pp. 519–523.) The full analysis of the former circuit was given in the paper dealt with in 4129 of 1936 : for von Ardenne's circuit *see* 1581 of 1936.

222. Interference with Television Programmes due to Apparatus for Ultra-Short-Wave Diathermy.—Esau & Roth. (*See* 81.)

223. Frequency Spectrum of the Disturbing Voltage in the Space External to Slightly Eccentric [Television] Cables [Magnetic Crosstalk Effect: Mathematical Treatment with Appropriate Approximations for Induction Coefficients between Cable and External Telephone Lines, for Cable with and without Iron Sheath: Frequency Spectra of Voltage induced in Telephone Lines: Voltage Maximum in Medium Frequency Range].—H. Buchholz. (*E.N.T.*, Sept. 1936, Vol. 13, No. 9, pp. 310–328.)

224. The Optimum Cross-Section of the Symmetrical Wide-Band Cable [for Television: Calculations].—F. Kirschstein: Green, Leibe & Curtis. (*E.N.T.*, Sept. 1936, Vol. 13, No. 9, pp. 283–295.)

See also 2605 of 1936. The writer of the present paper states that the results of the two papers are in practical agreement. He calculates "from simple electrostatic principles" the distribution of current density, the eddy-current losses in the screens, impedance, etc., and deduces rules for the optimum dimensions of the cable cross-section.

225. Other Papers relating to Television.—(*See* 26, 107, and **127**.)

226. Further Experiments with High-Voltage Cathode-Ray [Projecting] Receivers for High Definition.—von Ardenne. (*Funktech. Monatshefte*, Sept. 1936, No. 9, Supp. pp. 68–69.)

Further development of the apparatus dealt with in 4126 of 1936 in which a sustained brightness of 885 lumens was announced. By improving the matching of the tube dimensions with the conditions existing at the 24 000 volts employed, the ray current has been quadrupled or more, till it has approached the limiting value allowed by the space charge for the given convergence angle and spot diameter. The data are:—ray current 0.37 mA; ray power 9 W; luminous output at screen about 4 Hefner-Candles/w for a $6\frac{1}{2} \times 8$ cm raster; brightness 400 lumens. The line thickness was about 0.35 mm (suitable for 180 lines). In his discussion of the optical arrangements when the apparatus is used as a projecting receiver, the writer contrasts the requirements of a home television equipment with that of a public cinema as regards the necessary angles of observation, horizontal and vertical: for home television he considers that these may be about 30° and 15° respectively, so that screens may be used which have some four times the reflecting power of diffusely reflecting screens. He concludes that for a convenient size of such a screen ("mirror-raster" or "channeled" aluminium, with half a sq. metre surface) there is just enough brightness available (some 20 lux) to compare not too badly with cinema projection; this however applies only to 180 lines, the 375-line picture necessarily brings the brightness down to a quarter, and much work remains to be done before this loss can be made good in a satisfactory manner. It is mentioned that with the wide-aperture lenses used in the equipment described, the depth of focus is so small that care must be taken to make the fluorescent screen as flat as possible. *See* also 232, below.

227. The Development and Importance of the Cathode-Ray Tube for Television [Historical Survey: Possible Developments].—F. Schröter. (*Hochf:tech. u. Elek:akus.*, Sept. 1936, Vol. 48, No. 3, pp. 77–81.)

228. Cold Cathode-Ray-Light Scanner for Television Purposes.—W. Schnabel. (*Arch. f. Elektrot.*, 22nd July, 1936, Vol. 30, No. 7, pp. 461–475.)

A scanning tube is described (Fig. 3) which gives power up to 12 watts in the scanning beam with voltages of 10–12 kv. The returning beam is locked (Fig. 7) to prevent its track being seen on the pictures. The fluorescent screen and its charging-up are discussed; disturbances arising from this cause are eliminated by sputtering a transparent silver film over the inside of the tube and screen. A thyratron circuit for producing the "kipp" oscillations is given (Fig. 11); it is notable for the small number of valves used and employs symmetrical voltages for the line deviation. The photocurrent amplifier is described (§ IV); the fluorescent spot is used as a self-controlling light source and the photocell as a photoelectric generator. Fig. 12 shows a modulating bridge circuit, Fig 13 the arrangement for calibrating amplifiers. The effect of the fluorescent material used at the emitter on the definition of the received picture is discussed and illustrated by a series of screen photographs. A circuit is given (Fig. 25) for electrical compensation, at the emitter, of the afterglow effects.

229. A Time Base employing Hard Valves [Thyratron replaced by Two High-Vacuum Valves: Sychronising Methods: the "Syncher" Valve: Measurement of Traverse Velocity].—O. S. Puckle. (*Journ. Television Soc.*, June, 1936, Series 2, Vol. 2, Part 5, pp. 147–155.)

230. Notes on the Design of a Line-Scanning Transformer.—D. M. Johnstone. (*Journ. Television Soc.*, June, 1936, Series 2, Vol. 2, Part 5, pp. 138–146.)

231. Television "Spectacles" [Suggested Eye-Piece Set using Miniature Cathode-Ray Tubes].—(*Wireless World*, 30th Oct. 1936, Vol. 39, p. 458.)

232. Experiments and Measurements on Stereoscopic Projection with Polarised Light.—M. von Ardenne. (*Zeitchr. f. tech. Phys.*, No. 10, Vol. 17, 1936, pp. 332–337.)

"The properties of dichroitic polarisation filters are investigated with regard to their application for space film projection. An apparatus is described with which the reflection characteristics of a number of known projection screens are measured with normal and polarised light. It is found that *either* a scattering angle sufficient for a cinema theatre of normal construction *or* sufficiently small depolarisation is obtained. The two conditions can be fulfilled at once only by using mirror 'raster' surfaces, which are described." *See* also 3857 of 1936.

233. "Television Optics" [Book Review].—L. M. Myers. (*World-Radio*, 13th Nov. 1936, Vol. 23, p. 8.)

234/5. ON THE LIGHT INERTIA OF GASEOUS DISCHARGE TUBES.—W. Romanov. (*Tech. Phys. of USSR*, No. 9, Vol. 3, 1936, pp. 778–785: in German.)

With mercury at 100–850 mm the inertia increases with frequency (Fig. 7 & lower curves of Fig. 4): with mercury at 30–50 mm it decreases as the frequency increases beyond a certain point (Fig. 6 & upper curve of Fig. 4). Low-pressure sodium and neon tubes behave like the low-pressure mercury tubes (Figs. 9 & 10 appear to be wrongly numbered). In the discharge plasma of the low-pressure tubes, a.f. oscillations occur with d.c. feed, and the inertia decrease with increasing a.c. frequency is attributed to these oscillations, which reinforce the measured variable photocurrents in the particular frequency zone. The high-pressure tubes are the important ones for television, since only they can provide intense light: at 14 kc/s these show a four- to eight-fold reduction of the variable component, indicating considerable inertia. For Russian version see *Journ. of Tech. Phys.* [in Russian], No. 9, Vol. 6, 1936, pp. 1520–1526.

236. ALMOST INERTIA-LESS CONTROL OF LIGHT BY SUPERSONIC WAVES.—H. E. R. Becker. (*Hochf:tech. u. Elek:akus.*, Sept. 1936, Vol. 48, No. 3, pp. 89–91.)

Development of work referred to in 3475 of 1936. Modulated h.f. oscillations are impressed on the quartz crystal, which can be driven at frequencies up to those required for television by using optical arrangements with a Nipkow disc, as shown in Figs. 2, 3. The inertia of the device is found to be determined in practice only by the transit time of the acoustic wave across the liquid in the trough.

237. THE KERR EFFECT IN NITROTOLUOL [Temperature Variation].—F. Gabler & P. Sokob. (*Naturwiss.*, 4th Sept. 1936, Vol. 24, No. 36, p. 570.) For method *see* 3100 of 1936.

238. VARIATION WITH TEMPERATURE OF THE ELECTRIC DOUBLE REFRACTION (KERR EFFECT) OF A LIQUID MIXTURE WITH A CRITICAL MIXING POINT.—A. Goldet. (*Comptes Rendus*, 19th Oct. 1936, Vol. 203, No. 16, pp. 716–718.)

239. "HANDBUCH DER EXPERIMENTAL PHYSIK: PART I—MAGNETOOPTIK" [Book Review].—W. Schütz. (*Review Scient. Instr.*, Oct. 1936, Vol. 7, No. 10, p. 373.)

240. AN APPARATUS FOR THE TRANSFORMATION OF LIGHT OF LONG WAVELENGTH INTO LIGHT OF SHORT WAVELENGTH. II—THE INFLUENCE OF MAGNETIC FIELDS.—F. Coeterier & M. C. Teves. (*Physica*, Nov. 1936, Vol. 3, No. 9, pp. 968–976: in English.)

In the early form of the "image transformer" (1934 Abstracts, p. 331) only an elementary form of electron optics was employed. The present writers have obtained considerably improved results by using a combination of a simple electrostatic accelerating field and the magnetic focusing field given by a long coil. Rotation of the image is avoided by using a permanent ring magnet instead of an electro-magnet. The production of satisfactory transparent photocathodes and transparent fluorescent screens, possessing electrical conductivity, is discussed. A transparent film of platinum is used below the caesium-treated silver layer (in the case of the photocathode) to provide the necessary conductivity, and is prevented from losing its conductivity when exposed to the air by a very thin coating of quartz. A similar construction is used for the screens, and it is found incidentally that the fluorescent powder adheres much better to the sublimed quartz layer than to a glass surface.

241. THE CONSTRUCTION OF TRANSPARENT AND ELECTRICALLY CONDUCTING PHOTOCATHODES AND FLUORESCENT SCREENS.—Coeterier & Teves. (*See* 240.)

242. NEW CURRENT-MULTIPLYING VALVES: THE FARNSWORTH MULTIPACTOR AND THE CASTELLANI T-TUBE.—Saic. (*Funktech. Monatshefte*, Oct. 1936, No. 10, pp. 371–372.)

Although occurring in the title, the Castellani valve (announced from Mailand) is only mentioned as resembling the Zworykin T-tube. "So far as is known, this tube is already being made industrially and employed—successfully according to reports—for television."

243. ON SECONDARY-EMISSION ELECTRON MULTIPLIERS.—L. A. Kubetski. (*Automatics & Telemechanics* [in Russian], No. 1, 1936, pp. 17–29.)

Kubetski's work was referred to in 4145 of 1936 (Shmakov). In the present paper a general discussion of the subject is presented together with the main theoretical considerations. A survey of the work carried out at the Telemechanics Institute of U.S.S.R. is given, and the latest (ring type) electron multiplier developed there is described. This multiplier is essentially a vacuum tube with a number of silver rings deposited on its inner surface and inclined at an angle to the longitudinal axis. If gradually increasing potentials are applied to the consecutive rings and the tube is placed in a magnetic field perpendicular to its axis, the electrons emitted from one of the rings are deflected to the inner surface of the next ring, from which a greater number of electrons are liberated. Tubes were constructed on this principle having an amplification factor of 500 000 and more. The output current-intensity/illumination characteristic of this multiplier is a straight line and the modulation characteristic showing the output current for various voltages applied to one of the rings also has an almost straight portion.

On the basis of the theoretical and experimental results obtained, various fields of application of electron multipliers are discussed.

244. THE DEPTH AT WHICH SECONDARY ELECTRONS ARE LIBERATED.—Bruining. (*See* 117.)

245. THE RECIPROCAL RELATION BETWEEN THE EMISSION OF SECONDARY ELECTRONS WITH PHOTOSENSITIVITY AND THE THERMO-ION EFFECT.—A. Dobrolyubski. (*Zeitschr. f. Physik*, No. 9/10, Vol. 102, 1936, pp. 626–628.) *See* also 248.

246. SOFT X-RAYS AND PHOTOELECTRONS FROM NICKEL AT DIFFERENT TEMPERATURES [and the Increase of Secondary Emission at Curie Point].—Rao. (*Current Science*, Bangalore, Aug. 1936, Vol. 5, No. 2, pp. 73–74.)

247. THE OPTICAL CONSTANTS OF THIN SILVER FILMS.—Goos. (*See* 30.)

248. ON THE SECONDARY ELECTRON EMISSION FROM COMPOSITE SURFACES.—A. N. Dobrolyubski. (*Journ. of Tech. Phys.* [in Russian], No. 9, Vol. 6, 1936, pp. 1489–1496.)

An account of experiments carried out with three-electrode vacuum photocells (Fig. 1) having the electrodes made from one of the following materials: Ba-Ni, Ag_2O-Ag, Cs-Ag_2O-Ag, and Cs-Cs_2O-Ag.

The following observations were made:—(a) the variation of the secondary emission coefficient due to the variation of the energy of the primary electrons; (b) the energy distribution of the secondary electrons; (c) the saturation effect of the secondary emission; (d) the relationship between the secondary emission coefficient and the light sensitivity of the electrode; and (e) the effect of the density and the angle of incidence of the primary beam on the secondary emission coefficient. A number of experimental curves are shown and a theoretical interpretation is given of the results obtained. *See* also 245.

249. ON THE THEORY OF THE GAS-FILLED PHOTO-DYNATRON.—N. D. Morgulis. (*Journ. of Tech. Phys.* [in Russian], No. 9, Vol. 6, 1936, pp. 1497–1501.)

In order to raise the secondary-emission current in a three-electrode photocell (Fig. 1) the cell may be filled with some inert gas such as argon at a pressure of the order of 0.1 mm Hg. Owing to ionisation of the gas and the striking of the electrodes by the ions, the number of secondary electrons liberated from the electrodes will be increased and the secondary-emission current thus raised. In the present paper a quantitative analysis is given of the processes taking place in such a cell, and a formula (14) is derived determining the total amplification factor.

250. THALLOFIDE CELL [Photoelectric Resistance depending on Internal Photoelectric Effect: Spectral Sensitivity Curve: Illumination/Current Curve: Use in Infra-Red Telephony and Relays].—(*E.T.Z.*, 24th Sept. 1936, Vol. 57, No. 39, p. 1117: short note only.)

251. THE PETOSCOPE: A NEW PRINCIPLE IN PHOTOELECTRIC APPLICATIONS.—Fitzgerald. (*See* 435.)

252. FREQUENCY VARIATION OF BARRIER-LAYER PHOTOCELLS.—F. W. Gundlach. (*Arch. f. Elektrot.*, 15th Oct. 1936, Vol. 30, No. 10, pp. 625–637.)

The alternating voltages arising from alternating illumination of barrier-layer photocells were measured by balancing them against the voltage given by a vacuum photocell under the same illumination. The results were considered in the light of an equivalent circuit (Fig. 12) corresponding to the theory of von Auwers & Kerschbaum (1931 Abstracts, p. 103). The resistance and capacity of the barrier layer depend on the direct current flowing through it. The sensitivity and frequency variation can be much improved by impressing on the cell a direct current in the barred direction.

253. THE SELENIUM RECTIFIER PHOTOCELL: MANUFACTURE, PROPERTIES, AND USE IN PHOTOMETRY.—J. S. Preston. (*Journ. I.E.E.*, Oct. 1936, Vol. 79, No. 478, pp. 424–434: Discussion pp. 448–452.) From the N.P.L.

254. THE SELENIUM RECTIFIER PHOTOELECTRIC CELL: ITS CHARACTERISTICS AND RESPONSE TO INTERMITTENT ILLUMINATION.—J. J. MacGregor-Morris & R. M. Billington. (*Journ. I.E.E.*, Oct. 1936, Vol. 79, No. 478, pp. 435–448: Discussion pp. 448–453.) Including the use of the Campbell-Freeth compensation circuit and the desirability or otherwise of applying an external voltage.

255. PHOTOELECTRIC PROPERTIES OF BARIUM AND CALCIUM [Measurements of Constants, Temperature Coefficients, Absolute Photoelectric Yield, Optical Reflection Coefficient: Calcium Surface not homogeneous after Heating].—N. C. Jamison & R. J. Cashman. (*Phys. Review*, 1st Oct. 1936, Series 2, Vol. 50, No. 7, pp. 624–631.)

256. NOTE ON THE ANALYSIS OF PHOTOELECTRIC DATA [Comparison of Different Methods of Plotting for Determination of Work Function].—R. J. Cashman & N. C. Jamison. (*Phys. Review*, 15th Sept. 1936, Series 2, Vol. 50, No. 6, pp. 568–569.)

257. THE PHOTOELECTRIC PROPERTIES OF ZINC [Measurements of Work Function and Its Variation with Air Pressure].—C. F. DeVoe. (*Phys. Review*, 1st Sept. 1936, Series 2, Vol. 50, No. 5, pp. 481–485.)

258. THE CHEMICAL CONDITIONS OF THE PHOTOELECTRICALLY ACTIVE HYDROGEN LOAD OF PLATINUM AND TANTALUM.—K. Reger. (*Zeitschr. f. Physik*, No. 3/4, Vol. 102, 1936, pp. 156–162.)

Continuation and extension of Bethe's experiments (1933 Abstracts, p. 278). It is found that absolutely pure molecular hydrogen is not photoelectrically active when adsorbed on platinum or tantalum. The presence of impurities (in particular oxygen) or the dissociation of the hydrogen into atoms is necessary for photoelectric action.

259. THE LUMINESCENCE OF SOLID SUBSTANCES PRODUCED BY DIRECT EXCITATION IN A GEISSLER DISCHARGE TUBE [is due mainly to the Action of Ultra-Violet Radiation].—M. Servigne. (*Comptes Rendus*, 28th Sept. 1936, Vol. 203, No. 13, pp. 581–583.)

260. OPTICAL ABSORPTION BY THE ALKALI HALIDES [Theoretical Investigation of Relations between Three Types of Theory].—J. C. Slater & W. Shockley. (*Phys. Review*, 15th Oct. 1936, Series 2, Vol. 50, No. 8, pp. 705–719.)

261. ELECTRONIC ENERGY BANDS IN SODIUM CHLORIDE [with Difficulties of calculating Ultra-Violet Absorption Frequency].—W. Shockley. (*Phys. Review*, 15th Oct. 1936, Series 2, Vol. 50, No. 8, pp. 754–759.)

262. On the Electronic Constitution of Crystals; LiF and LiH [Computations].—D. H. Ewing & F. Seitz. (*Phys. Review*, 15th Oct. 1936, Series 2, Vol. 50, No. 8, pp. 760–777.)

263. Measurement of the Number of Colour Centres in KCl Crystals [Analytical Chemical Method of determining Factor of Proportionality of Colour Centres to Product of Maximum Absorption Constant and Width of Absorption Band: Calibration of Optical Determination].—F. G. Kleinschrod. (*Ann. der Physik*, Series 5, No. 2, Vol. 27, 1936, pp. 97–107.)

264. Electrical Observations on the Optical Formation and Disappearance of Colour Centres in KBr and KCl Crystals [Measurements of Optical Absorption Spectrum and Spectral Distribution of Currents produced in Crystal by Light: This does not agree with Photochemically Effective Absorption of Light: Unknown X-Centres cause Photoelectric Currents].—G. Glaser. (*Ann. der Physik*, Series 5, No. 3, Vol. 27, 1936, pp. 217–232.)

265. The Primary Photoelectric Current in KBr Crystals containing Colour Centres in an Alternating Electrical Field [Specific Photoelectric Conductivity as Function of Frequency: Saturation Value: Mean Free Paths of Electrons limited only by Their Length of Life and not by Granular Structure].—A. Naumann. (*Ann. der Physik*, Series 5, No. 3, Vol. 27, 1936, pp. 233–242.)

266. Production of Discoloration and Luminescence by Becquerel Rays. IV [Report on Recent Viennese Papers on the Production of Colour Centres in Natural Crystals of Rocksalt, Fluorite, etc.].—K. Przibram. (*Zeitschr. f. Physik*, No. 5/6, Vol. 102, 1936, pp. 331–352.)

MEASUREMENTS AND STANDARDS

267. The Measurement of Electric Field Strengths at [Ultra-] High Frequencies [by Heat generated in a Polar Dielectric].—S. J. Braude. (*Physik. Zeitschr. der Sowjetunion*, No. 1, Vol. 10, 1936, pp. 106–110: in German: *Journ. of Tech. Phys.* [in Russian], No. 8, Vol. 6, 1936, pp. 1352–1355.)

Debye (1934 Abstracts, p. 283) gave the formula (1) for the relation between the quantity of heat set free in a polar dielectric and the electric field in which it finds itself, and calculated the relaxation times τ for several substances; these were of the order of 10^{-12}, so that the maximum heating for such substances would be produced by wavelengths of a few millimetres. To produce sufficient heating, for measuring purposes, by ultra-short and decimetre waves, a container of some 60 cm^3 volume would be required. Now, however, the author has checked Malsch's value for τ for hexyl alcohol (2352 of 1935) and uses this liquid for field-strength measurement. With the long relaxation time possessed by a solution of hexyl alcohol in benzol, the container need be of only 2 cm diameter: a capillary tube of 0.7 mm diameter is fused into the bulb to act as indicator, and a curve is plotted giving the field strength as a function of distance between bulb and radiator.

268. Absorption and Dispersion Measurements on Electrolytic Solutions in Glycerine for Short Electric Waves [10–20 m; Conductivity Maximum at 14 m: Discussion by Debye Theory].—W. Schmacks. (*Ann. der Physik*, Series 5, No. 4, Vol. 27, 1936, pp. 285–298.)

269. Voltage Measurements at Very High Frequencies with the Diode Voltmeter.—M. von Ardenne. (*Hochf:tech. u. Elek: akus.*, Oct. 1936, Vol. 48, No. 4, pp. 117–120.)

For previous work on the diode voltmeter *see* Rohde, 1931 Abstracts, p. 393; Megaw, 1898 & 2332 of 1936; Fortescue, 3999 of 1935. Here a new form is described in which the frequency range is increased ten times, up to 1.5×10^9 c/s. The sources of error are first considered in so far as they limit the measurable frequency or amplitude ranges. The new form is designed to have very small capacity, with a definite but variable anode/cathode distance of 5 to 10×10^{-3} mm (Fig. 2), adjustable with a microscope drive. This eliminates transit time errors; errors due to voltages along the leads are also lessened by very short anode leads. The circuit is shown in Fig. 6; Fig. 8 gives the calibration curve and Fig. 9 the effect on the voltage reading of varying the electrode distance at different frequencies.

270. Method of comparing D.C. and Ultra-High-Frequency Current Calibrations of Thermo-Junction [by Photocell Calibration of Filament-Current/Luminosity of a Lamp].—S. M. Smith. (In Wright's paper, 288, below.)

271. The Measurement of Resistances, and of the Permittivity and Power Factor of Dielectrics, between 10^4 and 10^8 c/s.—Hartshorn & Ward. (*See* 351.)

272. Cathode Rays for the Ultra-High Frequencies [Accurate Voltage Measurements up to 300 Mc/s made possible with Cathode-Ray Oscillograph by Correction for Transit Time].—L. L. Libby. (*Electronics*, Sept. 1936, Vol. 9, No. 9, pp. 15–17.) In practice, it is proposed to use the cathode-ray oscillograph not directly but to calibrate a valve voltmeter.

273. The Measurement of Radio-Frequency Power [Possibilities of Cathode-Ray (and Planimeter) Wattmeter between 60 c/s and 40 Mc/s: Defects of "Lamp Load" Method].—A. H. Taylor. (*Proc. Inst. Rad. Eng.*, Oct. 1936, Vol. 24, No. 10, pp. 1342–1366.) "Indispensable" for certain problems and very rapid and convenient for others where too high an accuracy is not demanded. At 40 Mc/s the accuracy is probably not better than 15%. Power range down to 1/100th watt.

274. The Cathode-Ray Oscillograph as a Measuring Instrument [Survey].—E. Klein. (*Funktech. Monatshefte*, Oct. 1936, No. 10, pp. 377–385.)

275. Voltage Resonance and Its Applications [*e.g.* to Measurements of Dielectric Constants]. —M. Beauvilain. (*L'Onde Élec.*, Oct. 1936, Vol. 15, No. 178, pp. 650–658.)

Voltage resonance, " whose properties and applications, though little known, are very interesting " and very simple to use, is given—in the usual case when tuning is done by condenser variation—by $C_{res} = L/(R^2 + L^2\omega^2)$, instead of by the relation $C_{res} = 1/L\omega^2$ holding for current resonance: in general, R^2 is negligible compared with $L^2\omega^2$, so that the two types of resonance occur at praticallly the same value of C and the resonance voltages are practically equal. The logarithmic decrement is given by $\delta/\pi = (C_1 - C_2)/2C_{res}$ for voltage resonance and $= (C_1 - C_{res})/C_1$ for current resonance: if the latter relation is applied, as it sometimes is, to voltage resonance, the error is the greater the higher the damping of the circuit. Voltage resonance is easily observed by introducing the circuit into the grid circuit of the first valve of any valve-voltmeter. Applications here described are the measurement of the h.f. resistance of an oscillating circuit or of a high resistance, and the determination of a capacity which is shunted by resistances from which it cannot be separated. The author has used the principle for measuring the dielectric constant of electrolytes.

276. A Method for measuring the Dielectric Constant, Specific Conductivity and Angle of Loss of Liquid and Granular Bodies at Ultra-High Frequencies.—K. S. Belyakova. (*Journ. of Tech. Phys.* [in Russian], No. 9, Vol. 6, 1936, pp. 1561–1573.)

A theory is developed for measuring a complex load connected at the end of a Lecher system, by noting the distribution of currents and voltages in the system. On the basis of this theory a method is proposed in which the material under investigation is placed in a condenser terminating a Lecher system. The apparatus developed for this purpose is described and the procedure to be followed in the measurements is discussed in detail. A table is given showing the results obtained for such materials as benzol, glycerine, flax oil, yeast-dough, barley, etc.

277. The Dielectric Constant of Mercury Vapour as a Function of Density for Various Temperatures [Measurements show Constancy of Claudius-Mossotti Expression].—P. Wüsthoff. (*Ann. der Physik*, Series 5, No. 4, Vol. 27, 1936, pp. 312–328.)

278. Indication of a Decrease in the Polarisability of a Non-Polar Molecule by Pressure [from Measurements of the Dielectric Constant of CO_2].—Michels, Michels-Veraart & Bijl. (*Nature*, 19th Sept. 1936, Vol. 138, pp. 509–510.)

279. Anomalous Behaviour of the Dielectric Constant of High-Order Organic Acids near the Solidifying Point.—B. Piekara. (*Physik. Zeitschr.*, 1st Sept. 1936, Vol. 37, No. 17, pp. 624–627.)

280. Measurements of Small Conductivities and Dipole Losses with Long Waves [18 000–170 m: Method of Simultaneous Measurement of Small Conductivities, Dipole Losses and Dielectric Constant, using Barretter Arrangement: Measurements with Organic Liquids].—C. Schreck. (*Ann. der Physik*, Series 5, No. 3, Vol. 27, 1936, pp. 261–284.)

281. Measurement of the " Angle of Circulation " in Amplifiers.—Tiberio. (*See* 72.)

282. Logarithmic Valve-Voltmeter for Audio-Frequencies.—W. Holle & E. Lubcke. (*Hochf:tech. u. Elek:akus.*, Aug. 1936, Vol. 48, No. 2, pp. 41–45.)

The instrument here described (circuit Fig. 6) has a range of 80 db with a regulating speed of 750 db/sec. Self-oscillation is avoided by the use of (1) a circuit tuned to a very low frequency working in a limiting aperiodic condition, and (2) a push-pull regulating amplifier (§ I). The problem of regulation is considered in general (§ II) with the various possible regulation functions and characteristics (Figs. 2–5). The valves required (§ III) and the finished instrument (§ IV) are described; Fig. 8 shows its characteristic and frequency curves. Its applications to the investigation of the frequency curves of a dynamic loudspeaker (with discussion of the question whether a triode or a pentode should be used in the last stage of the receiver) and to measurements of absorption of sound by walls are discussed in § V.

283. The Rectifier Method for High-Voltage Measurement with Glow-Discharge Rectifiers.—J. L. Jakubowski. (*Arch. f. Elektrot.*, 22nd July, 1936, Vol. 30, No. 7, pp. 430–445.)

284. Some New High-Tension Measuring Instruments [Ionic Wind Voltmeter: Ballistic Electrostatic (Ellipsoid) Voltmeter].—W. M. Thornton. (*Journ. I.E.E.*, Oct. 1936, Vol. 79, No. 478, pp. 483–486.) For transient as well as steady voltages or currents.

285. Voltage Measurement using Limiting Voltages [between Two Discharge Forms] and Spark Voltages.—M. Toepler. (*Arch. f. Elektrot.*, 15th Oct. 1936, Vol. 30, No. 10, pp. 663–670.)

286. The Exact Measurement of the Electrical Conductivity and the Permeability of Iron Wires [Calculations and Measurements of Impedance of Stretched Wire and Ring Coil with Wire Core].—E. Rath. (*Arch. f. Elektrot.*, 15th Oct. 1936, Vol. 30, No. 10, pp. 651–662.)

287. "Principles of Electric and Magnetic Measurements" [Book Review].—P. Vigoureux & C. E. Webb. (*Review Scient. Instr.*, Oct. 1936, Vol. 7, No. 10, p. 367.)

288. Marconi Ultra-Short-Wave Standard Signal Generator [20–100 Mc/s : Continuously Variable Output 0.0005–100 mV].—F. M. Wright. (*Marconi Review*, July/Aug. 1936, No. 61, pp. 30–34.) *See* also Smith, 270, above.

289. Thyratron-Operated Wave Generator.—Rajam. (*See* 175.)

290. A Laboratory-Type Beat-Frequency Audio Oscillator and R. F. Signal Generator.—De Soto. (*QST*, Oct. 1936, Vol. 20, No. 10, pp. 41–45 and 102.)

291. A New D.C. Power-Measuring Bridge with Automatic Balancing [using Triode as Variable Resistance with Grid Bias controlled by Special M.C. Meter Movement without Mechanical Restoring Force].—K. Sauermann. (*E.T.Z.*, 12th Nov. 1936 Vol. 57, No. 46, pp. 1317–1319.)

292. Electrostatic Screening of A.C. Bridges in the Note-Frequency Range [Survey].—Th. Walcher. (*E.T.Z.*, 19th Nov. 1936, Vol. 57, No. 47, p. 1352 : summary only.)

293. A New Alternating-Current Null Indicator [Sensitivity at least equal to that of Conventional D.C. Null Indicators].—Gieringer. (*Review Scient. Instr.*, Nov. 1936, Vol. 7, No. 11, pp. 414–419.) A d.c. meter is used with a rectifier in a special circuit giving an a.c. bias, whose effects are balanced out of the indicator. Without this bias the combination is definitely unsatisfactory.

294. Spot and Short-Period Galvanometers.—Cambridge Inst. Company. (*Journ. Scient. Instr.*, Nov. 1936, Vol. 13, No. 11, pp. 372–374.)

295. A Standard Element of Small Voltage [composed of Cd Amalgams of Different Concentrations].—W. Gremmer. (*Physik. Zeitschr.*, 15th Oct. 1936, Vol. 37, No. 20, pp. 697–699.)

296. Progress in the Astronomical Determination of Time [Short Summarising Report : Wireless Signals : Quartz Clocks].—H. C. Freiesleben. (*Naturwiss.*, 9th Oct. 1936, Vol. 24, No. 41, pp. 648–650.)

297. The Exact Measurement of Radio Frequencies.—A. Sabbatini. (*Alta Frequenza*, Oct. 1936, Vol. 5, No. 10, pp. 630–650.)

Description of the equipment used in the P.T.T. Section of the Experimental Institute of Communications in Rome. The secondary standard is a 1000-c/s Sullivan fork driving a synchronous clock for checking against time signals. The frequencies to be measured are compared by the beat method with the frequency of a very stable oscillator working between 100 and 250 kc/s ; the comparison is made either directly or (for the higher frequencies up to 25 Mc/s) after frequency division. The oscillator itself is checked against the harmonics of the fork or of a 10 kc/s circuit synchronised by the fork.

298. A New Precision Quartz Wavemeter.—L. Bergmann. (*Hochf:tech. u. Elek:akus.*, Sept. 1936, Vol. 48, No. 3, pp. 87–89.)

The principle of this wavemeter is that "an optical image of a slit is formed through a quartz plate excited piezoelectrically in its harmonics. The distance of the first-order diffraction images thus formed is measured by a micrometer eyepiece. This distance gives at once the order of the harmonic in question and, once the quartz has been calibrated, the frequency of the oscillation which is exciting the quartz." Experimental results are tabulated.

299. The Temperature Coefficients of Shear and Longitudinal Modes of Vibration [No Unique Angle of Orientation, independent of Crystal Dimensions, gives Zero Coefficient for Shear Mode : Application to grinding Quartz Plates of Lower Coefficient].—H. Osterberg. (*Review Scient. Instr.*, Sept. 1936, Vol. 7, No. 9, pp. 339–341.)

300. Intensity of the Central Spot produced by X-Rays penetrating Piezoelectrically Oscillating Quartz Crystals [No Certain Change in Intensity found : Fox & Fraser's Result due to Accidental Circumstances].—G. E. M. Jauncey & A. T. Jaques. (*Phys. Review*, 1st Oct. 1936, Series 2, Vol. 50, No. 7, p. 672.) *See* also 285 of 1936 and 3188 of 1935.

301. Measurement of Damping Decrements in Piezo-Crystals.—H. Gockel. (*Physik. Zeitschr.*, 15th Sept. 1936, Vol. 37, No. 18, pp. 657–659.)

"A method is described by which the damping decrement of oscillating piezo-crystals may be determined from the natural decrease in the oscillations of the free, unloaded crystal. The measurements show that the damping is in general greater for substances in which the velocity of sound is small. The decrement is, to a great extent, dependent on the nature of the crystal surface. In addition to quartz and tourmaline, asparagine appears to be suitable for technical applications."

302. Asparagine as a Piezoelectric Crystal.—Gockel. (*See* 301.)

303. The Temperature Variation of the Elastic Moduli of NaCl, KCl and MgO [measured with Composite Piezoelectric Oscillator of Quartz and the Crystal under Investigation].—M. A. Durand. (*Phys. Review*, Series 2, Vol. 50, No. 5, pp. 449–455.) For method *see* also Rose, 2327 of **1936.**

304. Crystalline Symmetry and Shear Constants of Rochelle Salt.—R. Taschek & H. Osterberg. (*Phys. Review*, 15th Sept., 1936, Series 2, Vol. 50, No. 6, p. 572.)

305. The Piezoelectric Properties of Rochelle Salt.—Norgorden : Mueller. (*See* 161.)

306. A New Precision Frequency Recorder [for Commercial Frequencies: Accurate to ± 0.02%: Continuous Ink-Writing].—W. Geyger. (*E.T.Z.*, 19th Nov. 1936, Vol. 57, No. 47, pp. 1337–1340.)

307. Sensitive Frequency Meter with Pointer [for measuring Mains Frequency: Wattmeter System on Phase Jump Principle: One Rotating Coil acts simultaneously as Measuring and Spring Coil].—H. Boekels & F. W. Müller. (*E.T.Z.*, 29th Oct. 1936, Vol. 57, No. 44, pp. 1259–1261.)

308. The Calibration of High-Sensitivity Frequency Meters [with Full-Scale Range of 2 Cycles or less: for Photoelectric Frequency Recorders, etc.].—S. C. Richardson. (*Gen. Elec. Review*, Oct. 1936, Vol. 39, No. 10, pp. 501–503.) For such a recorder *see* La Pierre, 1933 Abstracts, p. 581.

309. A Thyratron Stroboscope [for Frequency Measurement].—Spilsbury. (*Journ. I.E.E.*, Nov. 1936, Vol. 79, No. 479, pp. 585–587: Discussion pp. 589–594.) *See* also 2330 of 1936.

310. The Inductance of Iron-Cored Coils having an Air Gap [Curves of Variation of Inductance with Length of Gap: Method of Estimating Effect of Leakage: Formula for Calculation of Inductance for Iron Stampings with Rectangular Window and Air Gap in Longer Side].—G. F. Partridge. (*Phil. Mag.*, Oct. 1936, Series 7, Vol. 22, No. 148, pp. 665–678.)

311. Calculation of the Electromagnetic Field of a System of Coils with a Straight Core of Circular Section and Indefinite Length [and Infinite Permeability: Formulae for Magnetic Induction at Any Point: Indication of Method of Numerical Calculation].—J. Loiseau. (*Rev. Gén. de l'Élec.*, 26th Sept. 1936, Vol. 40, No. 13, pp. 390–397.)

312. Discussion on "The Alternating-Current Resistance of Tubular Conductors."—Arnold. (*Journ. I.E.E.*, Nov. 1936, Vol. 79, No. 479, pp. 595–596.) *See* 2759 of 1936.

313. The Determination of Absolute Units [Analysis of Method of Calibration of Units: Experimental Laws involved: Arbitrary Assumptions introduced].—N. Campbell. (*Proc. Phys. Soc.*, 1st Sept. 1936, Vol. 48, Part 5, No. 268, pp. 708–718: Discussion pp. 718–722.)

314. Classical Electrical Metrology and the Systems of Units derived from It: Critical Examination.—G. Giorgi. (*Rev. Gén. de l'Élec.*, 10th Oct. 1936, Vol. 40, No. 15, pp. 459–468.)

SUBSIDIARY APPARATUS AND MATERIALS

315. Some Phenomena in the Use of Controlled "Kipp" Oscillations as Time Axis for the Cathode-Ray Oscillograph.—Kaspar. (*Hochf:tech. u. Elek:akus.*, Aug. 1936, Vol. 48, No. 2, pp. 53–56.)

The "kipp" (relaxation) oscillation is assumed to have a saw-tooth form and to produce a linear time base; an angular oscillation is the subject of investigation. Its wandering over the screen when the "kipp" oscillation is uncontrolled is investigated theoretically (§ I); the velocity of transit across the screen provides a means for the optical determination of frequency and frequency deviation. Synchronisation occurs when the angular oscillation is coupled into the grid circuit (§ II); in § III the time is calculated which elapses until photographic recording is possible. The variable parameters and the stability of the controlled "kipp" oscillations (§§ IV, V) and the deionisation and pre-striking times of the thyratron used (§ VI) are also considered.

316. The Cathode-Ray Oscillograph: Its Present Development, Application and Comparison.—von Borries. (*Zeitschr. V.D.I.*, 12th Sept. 1936, Vol. 80, pp. 1135–1141.)

317. A Method of Time Marking with a Cathode-Ray Oscillograph [Time Intervals down to below 1/100 000 th Sec. recorded on Rapidly Moving Films by use of Small C-R Oscillograph].—Whipple. (*Journ. Scient. Instr.*, Sept. 1936, Vol. 13, No. 9, pp. 291–295.)

318. A Versatile Oscillographic Assembly [Continuous-Viewing Oscillograph (with Synchronous Shutter Device) combined with Synchronous Contactor].—Kurtz & Corcoran. (*Gen. Elec. Review*, July, 1936, Vol. 39, No. 7, pp. 320–323.)

319. Experimental Verification of the Theory of the Cathode Ray Oscillograph: and the Influence of Screen Potential.—MacGregor-Morris & Hughes. (*Journ. I.E.E.*, Oct. 1936, Vol. 79, No. 478, pp. 454–462.)

Among other points, these measurements confirm that the supposed difference between the actual and calculated electrostatic sensitivities is connected with the fringing field at the edge of the deflecting plates and not with any variations in the beam velocity. The potential of the fluorescent spot is found to be about 60 v below that of the anode and independent of the beam current or energy over a wide range. The influence of this potential on the sensitivity of the beam is almost negligible.

320. Cathode-Ray Oscillograph [with System of Electrodes designed for Exact Placing, Good Focusing and High Spot-Luminosity].—van den Bosch. (*Rev. Gén. de l'Élec.*, 26th Sept. 1936, Vol. 40, No. 13, p. 102D: French Pat. 798 992 of 10.12.1935.)

321. Photographic Recording with Braun [Cathode-Ray] Tubes [Formula for Calculation of Recording Velocities attainable with External Photography with Camera and Lens: Oscillograms with Recording Velocities up to 17 km/sec.].—Bachem. (*Physik. Zeitschr.*, 15th Sept. 1936, Vol. 37, No. 18, pp. 650–655.) For a correction to a nomogram see *ibid.*, 15th Oct. 1936, No. 20, p. 736.

322. Construction of Electron Lenses with Spiral Resistances.—M. von Ardenne. (*Arch. f. Elektrot.*, 8th Sept. 1936, Vol. 30, No. 9, pp. 623–624.)

" In this electrostatic electron lens, the rise of potential along the axis is influenced by varying the pitch of a high-resistance metallic spiral against the interior of an insulating cylinder." The pitch required for any given potential distribution is determined by preliminary measurements in an electrolytic trough (*see* Knoll, 1934 Abstracts, p. 219, and von Ardenne, 3553 of 1936).

323. A Component Lens in Electrical Lens-Systems.—Hennig. (*Zeitschr. f. Physik*, No. 9/10, Vol. 102, 1936, pp. 629–632.)

The simple electrical lens is defined as " the field in the neighbourhood of a zero of the second derivative of the axis potential with regard to the distance along the axis " ; every axially symmetrical field can then be split up into simple lenses, whose number depends probably only on the number of electrodes. Any desired lens may then be composed of a given number of simple lenses. Scherzer's work on the weak electrical lens of smallest spherical aberration (3545 of 1936) is discussed in the light of this definition.

324. A New Effect observed on passing Electron Beams through Narrow Slits [Band-Like Structure of Emergent Beam due to Distribution of Electric Charges on Slit-Edges].—McFarlane. (*Phil. Mag.*, Nov. 1936, Series 7, Vol. 22, No. 149, pp. 801–810.)

325. Calculation of Electron-Optical Constants as an Eigenvalue Problem [Formulae for calculating Principal and Focal Points: Approximate Solution by Method of Ritz].—Funk & Glaser. (*Zeitschr. f. Physik*, No. 9/10, Vol. 102, 1936, pp. 603–610.) *See* also Glaser, 1933 Abstracts, p. 399.

326. The Theory of Image Errors in Electron-Optical Systems [Proof of Identity of Third Order Errors calculated by Glaser and by Scherzer].—Gratsiatos. (*Zeitschr. f. Physik*, No. 9/10, Vol. 102, 1936, pp. 641–651.) For Glaser's papers *see* 1934 Abstracts, p. 107, and 303 of 1936 ; for Scherzer's work see *Geometrische Elektronenoptik* (Brüche & Scherzer), p. 129.

273. Electron-Optical Photographs of Diatoms with the Magnetic Electron Microscope [Examples of Resolving Power and Efficiency of Microscope].—Krause. (*Zeitschr. f. Physik*, No. 5/6, Vol. 102, 1936, pp. 417–422.)

328. Some Considerations concerning the Resolving Power in Electron Microscopy [Distinction between " Surface " and " Depth " Resolving Powers : Approximate Calculation of the Latter].—Marton. (*Physica*, Nov. 1936, Vol. 3, No. 9, pp. 959–967 : in French.)

329. A Magazine Plate Camera for Photography in Vacuum [with High-Magnification Electron Microscope].—Fitzsimmons. (*Phys. Review*, 15th Aug. 1936, Series 2, Vol. 50, No. 4, p. 386 : abstract only.)

330. The Energy Distribution of Cathode Rays scattered Backwards [after impinging on Metal Surface : Velocity Spectrum determined by Magnetic Deflection : Discussion of Effects of Diffusion and Energy Loss].—Brand. (*Ann. der Physik*, Series 5, No. 7, Vol. 26, 1936, pp. 609–624.)

331. The Radial Distribution of Electrons in the Uniform Columns of Electrical Discharges.—Yarnold & Holmes. (*Phil. Mag.*, Nov. 1936, Series 7, Vol. 22, Supp. No. 150, pp. 988–998.)

332. Acceleration of Electrons in an Electromagnetic Alternating Current Field [Theory : Possibility of Circular Paths in Presence of Additional Radial Electric Field : Principles of Design of Practical Arrangement for producing Very High Electron Velocities].—Jassinsky. (*Arch. f. Elektrot.*, 8th Sept. 1936, Vol. 30, No. 9, pp. 590–603 : *Rev. Gén. de l'Élec.*, 19th Sept. 1936, Vol. 40, No. 12, pp. 355–365.)

333. The Glow Discharge at Low Pressures between Coaxial Cylinders in an Axial Magnetic Field.—Penning. (*See* 125.)

334. Direct-Voltage Technique for Quantitative Investigations on Nuclear Physics [with Construction of Focusing Vacuum Tube and Corona-Free Voltmeter Resistance].—Tuve, Hafstad & Dahl. (*Naturwiss.*, 2nd Oct. 1936, Vol. 24, No. 40, pp. 625–632.)

335. The Fluorescence of Rare Earths in Glasses [Fluorescence Spectra : Excitation Distributions].—Deutschbein. (*Zeitschr. f. Physik*, No. 11/12, Vol. 102, 1936, pp. 772–780.) Disagreement is expressed with the work of Prosad, Bhattacharya & Chatterjee (1282 of 1936) on didymium glass.

336. The Effect of Molecular Rotations on Measurements of the Decay Time of Fluorescence [Experimental Tests of Jabloński's Theory].—Kessel. (*Zeitschr. f. Physik*, No. 1/2, Vol 103, 1936, pp. 125–132.) *See* Szymanowski, 3208 of 1935.

337. An Investigation of the Decay of Phosphorescence in Boric Acid and Alumina Sulphate Phosphorescent Substances.—Lewschin & Vinokurov. (*Physik. Zeitschr. der Sowjetunion*, No. 1, Vol. 10, 1936, pp. 10–33 : in English.)

338. Electrostatic and Van der Waal Adsorption of Iodine on Fluoride Layers.—Custers & De Boer. (*Physica*, Nov. 1936, Vol. 3, No. 9, pp. 1021–1034 : in German.)

339. On Laws governing the Phosphorescence of X-Rayed Fluorite.—Gekzriken & Zhmudski. (*Journ. of Tech. Phys.* [in Russian], No. 9, Vol. 6, 1936, pp. 1530–1537.) Formulae are derived experimentally determining the duration of phosphorescence in terms of the duration and voltage of the X-rays.

340. FLEXIBLE HIGH-VACUUM SEALS [quickly made and removed: "Cenco Seals"].—(*Current Science*, Bangalore, Sept. 1936, Vol. 5, No. 3, p. 182.)

341. PYREX GLASS SEALS [and the Choice of the Intermediate].—Fraenckel. (*Review Scient. Instr.*, Oct. 1936, Vol. 7, No. 10, p. 395.)

342. ADSORPTION OF GASES AND GAS MIXTURES BY SPECIAL CARBONS [including the Production of a High Vacuum by Oxygen Adsorption].—Husung. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 17, 1936, pp. 289–301.)

343. A METAL OIL DIFFUSION PUMP—MULTIPLE NOZZLE TYPE.—Amdur. (*Review Scient. Instr.*, Oct. 1936, Vol. 7, No. 10, pp. 395–396.)

344. PAPER ON THE "IGNITRON" TYPE MERCURY-VAPOUR TUBE: EXPERIMENTAL DATA FOR STRIKING CONDITIONS: HYPOTHESIS OF MECHANISM.—Mierdel. (*E.T.Z.*, 17th Sept. 1936, Vol. 57, No. 38, p. 1090: summary only.)

345. GAS DISCHARGES WITH ANODES EMITTING IONS: THE LIBERATION OF ELECTRONS BY POSITIVE IONS AT BOUNDARY SURFACES [Current/Voltage Characteristics and Oscillograms: Physical Explanations].—Mahla. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 17, 1936, pp. 324–327.)

346. IRRADIATION AND BREAKDOWN [Theory of Law of Decrease of Breakdown Voltage with Weak Irradiation: Presence of Space Charge may cause Increases of Breakdown Voltage: Field Distortion: Current].—Rogowski & Wallraff. (*Zeitschr. f. Physik*, No. 3/4, Vol. 102, 1936, pp. 183–200.)

347. VARIATION OF STRIKING VOLTAGE BY IRRADIATION [of Cathode of Discharge Tube by Mercury Arc Lamp: Experiments show Increase of Striking Voltage, not the Decrease expected theoretically: Effect due to Short-Wave Ultra-Violet Spectrum]: PART I.—Fucks & Seitz. (*Zeitschr. f. Physik*, No. 1/2, Vol. 103, 1936, pp. 1–17.)

348. DEIONISATION AND RESTRIKING OF GRID-CONTROLLED GAS-DISCHARGE VESSELS.—Hermann. (*Arch. f. Elektrot.*, 8th Sept. 1936, Vol. 30, No. 9, pp. 555–580.)

The effect is investigated of variations of anode current, anode and grid voltages, vapour pressure and grid spacing on conditions of deionisation and restriking in a mercury discharge tube with incandescent filament. Deionisation is found to be almost independent of the electrode voltages; the restriking limit is reached after variable intervals depending on the magnitude of the negative grid voltage.

349. A SIMPLE METHOD FOR CORRECTING A COPPER-OXIDE RECTIFIER.—L. S. Freiman. (*Journ. of Tech. Phys.* [in Russian], No. 8, Vol. 6, 1936, pp. 1344–1348.)

It is usual to represent a copper-oxide rectifier as a resistance r_0 followed by another resistance r_1 in parallel with a capacity c_1 (resistance and capacity of the barrier layer). It is obvious that at higher frequencies a greater part of the current will pass through c_1 and that if the rectifier is connected in series with a voltmeter this will give different readings at different frequencies. The author shows that if a capacity c_2 is connected across the voltmeter resistance r_2 (Fig. 2) and $r_2 c_2 = r_1 c_1$, the current I through the voltmeter becomes independent of frequency. Methods are indicated for determining r_1 and c_1 from simple measurements, and some experimental curves are shown confirming the theoretical conclusions.

350. THE EFFECT OF HIGH PRESSURES ON THE PROPERTIES OF COPPER-OXIDE RECTIFIERS.—Sharavski. (*Journ. of Tech. Phys.* [in Russian], No. 9, Vol. 6, 1936, pp. 1531–1542.)

Experiments were carried out with copper-oxide rectifiers subjected to pressures up to 8000 atmospheres. It appears from these experiments that the rectification coefficient of the rectifiers, *i.e.* the ratio of the rectified current to the reverse current, is somewhat increased when the pressure is raised to between 4000 and 5000 atmospheres. With a further increase in the pressure the rectified current remains practically unaltered, but the reverse current rises considerably and the rectification coefficient is therefore lowered. Other experiments have shown that the conductivity of Cu_2O is independent of the pressure, and it is suggested that the variation of the rectification coefficient is due to changes taking place in the barrier layer between the Cu and the Cu_2O.

351. THE MEASUREMENT OF THE PERMITTIVITY AND POWER FACTOR OF DIELECTRICS AT FREQUENCIES FROM 10^4 TO 10^8 CYCLES PER SECOND [Capacitance-Variation Method applicable also to Resistance Measurement: with Some Results].—Hartshorn & Ward. (*Journ. I.E.E.*, Nov. 1936, Vol. 79, No. 479, pp. 597–609.) Frequency is not involved in the calculation; it is this which gives the method its very large frequency range.

352. MEASUREMENT OF THE BREAKDOWN FIELD-STRENGTHS OF SOLID INSULATING MATERIALS IN THE FREQUENCY RANGE 10^6 TO 15×10^6 C/S. DEVELOPMENT OF THE THEORY OF THERMAL BREAKDOWN.—Becker. (*Arch. f. Elektrot.*, 22nd July, 1936, Vol. 30, No. 7, pp. 411–429.)

353. MEASUREMENTS OF DIELECTRIC CONSTANT AND LOSS ANGLE OF LIQUID AND GRANULAR BODIES AT ULTRA-HIGH FREQUENCIES.—Belyakova. (*See* 276.)

354. A RECORD OF RECENT PROGRESS TOWARDS THE CORRELATION OF THE CHEMICAL COMPOSITION, THE PHYSICAL CONSTITUTION, AND THE ELECTRICAL PROPERTIES, OF SOLID DIELECTRIC MATERIALS.—Jackson. (*Journ. I.E.E.*, Nov. 1936, Vol. 79, No. 479, pp. 565–576.)

355. Some Aspects of the Electric Strength of Dielectrics [E.R.A. Report Ref. L/T 82: British Association Paper].—Whitehead. (*World Power*, Sept. 1936, Vol. 26, pp. 72–78.)

356. On the Anomalous Properties of Dielectrics [Theoretical Method of separating Hysteresis Losses from Absorption Losses: Method for Analytical Determination of Absorption Curve of Hysteresis-Free Dielectric: Graphical Method of Testing von Schweidler's Analysis].—Neufeld. (*Journ. Franklin Inst.*, Sept. 1936, Vol. 222, No. 3, pp. 327–336.) For von Schweidler's paper see *Ann. der Phys.*, Vol. 24, 1907, p. 711.

357. The Electrical Conductivity of Solid Dielectrics in Strong Electric Fields [up to 2000 kV/cm (for Glass): True Deviations from Ohm's Law proved].—Walter & Inge. (*Tech. Phys. of USSR*, No. 8, Vol. 3, 1936, pp. 700–714.) German version of the Russian paper referred to in 2813 of 1936.

358. The Sensitivity of the "Schlieren" Chamber [Observations of Pre-Discharge Canal: Estimate of Temperature Increase and Number of Electrons in Electron Avalanche].—Trey. (*Arch. f. Elektrot.*, 15th Oct. 1936, Vol. 30, No. 10, pp. 683–685.)

359. Residual Moisture in Cellulose Dielectrics [Colloidal Nature and Structure of Cellulose: Physical and Chemical Character of Typical Adsorption: Behaviour under Electric Stress].—Greenfield. (*Journ. Franklin Inst.*, Sept. 1936, Vol. 222, No. 3, pp. 345–358.)

360. Discussion on "Pyrochemical Behaviour of Cellulose Insulation."—Clark. (*Elec. Engineering*, Aug. 1936, Vol. 55, No. 8, pp. 901–903.) *See* 767 of 1936.

361. Plastic Applications in Radio.—Delmonte. (*Rad. Engineering*, Sept. 1936, Vol. 16, No. 9, pp. 21–23.)

362. Microchemical and Special Methods of Analysis in Communication Research.—Clarke & Hermance (*Bell S. Tech. Journ.*, Oct. 1936, Vol. 15, No. 4, pp. 483–503.)

363. Investigations on Breakdown and Phenomena in Electrical Applications of Insulating Oils of Different Degrees of Electrical Rigidity.—Conradi. (*Arch. f. Elektrot.*, 15th Oct. 1936, Vol. 30, No. 10, pp. 677–682.)

364. Current, Breakdown, and Supersonic Waves in Dielectric Liquids [Presence of Supersonic Waves with Oscillating Electrode gives Increased Conductivity and Marked Decrease in Resistance to Breakdown: Measurements for Various Organic Liquids].—Meyer. (*Zeitschr. f. Physik*, No. 5/6, Vol. 102, 1936, pp. 279–304.)

365. An Electron-Valve/Condenser Circuit for Graduation of Insulation in Steps.—Szpor. (*Arch. f. Elektrot.*, 22nd July, 1936, Vol. 30, No. 7, pp. 476–482.)

366. Temporal Hysteresis of the Charges in Electrical Brush Discharges [High-Voltage Gas Discharges along Dielectric Surfaces].—Schiering. (*Arch. f. Elektrot.*, 22nd July, 1936, Vol. 30, No. 7, pp. 455–460.)

367. Aqueous Electrolytic Condensers [Reservoir and Smoothing Types].—Telegraph Condenser Company. (*Engineer*, 13th Nov. 1936, Vol. 162, p. 528.)

368. Electrical Investigations on Oxide Semi-Conductors [Resistance of Al_2O_3 and Ta_2O_5 increases with Increasing Oxygen Content: Hall Effect in UO_2 and CuO: Nature of Conductivity in These Oxides].—Hartmann. (*Zeitschr. f. Physik*, No. 11/12, Vol, 102, 1936, pp. 709–733.)

369. Remark on the Paper by Rummel: "Experiments on the Constitution of Thin Electrolytic Oxide Films": Reply [Discussion of Discrepancy between Rummel's Value of Breakdown Voltage of Tantalum Oxide Films and That found by Just].—Betz: Rummel. (*Zeitschr. f. Physik*, No. 7/8, Vol. 102, 1936, p. 548: p. 549.) For Rummel's paper *see* 3576 of 1936.

370. On the Theory of Absorption and Dispersion in Paramagnetic and Dielectric Media [Debye Formulae as a Special Case of More General Formulae: Connection between Absorption and Dispersion: etc.].—Gorter & Kronig. (*Physica*, Nov. 1936, Vol 3, No. 9, pp. 1009–1020: in English.)

371. Paramagnetic Relaxation in a Transversal Magnetic Field.—Gorter. (*Physica*, Nov. 1936, Vol 3, No. 9, pp. 1006–1008: in English.) Further development of the work referred to in 3587 of 1936.

372. Theory of Constant Paramagnetism: Application to Manganese.—Néel. (*Comptes Rendus*, 27th July, 1936, Vol. 203, No. 4, pp. 304–306.)

373. Diamagnetism and Particle Size.—Lessheim. (*Current Science*, Bangalore, Sept. 1936, Vol. 5, No. 3, pp. 119–127.)

374. The Effect of Elastic Distortions on the A.C. Magnetisation Curve [Investigation of Magnetic Anisotropy of Ferromagnetic Wires with Magnetisation in Two Perpendicular Directions: Applicability of Becker's Theory in L.F. Fields].—Littmann. (*Ann. der Physik*, Series 5, No. 2, Vol. 27, 1936, pp. 186–200.)

375. Method of producing Uniform Magnetic Field.—Bacon. (*Review Scient. Instr.*, Nov. 1936, Vol. 7, No. 11, pp. 423–425.)

376. The Optimum Dimensions of Permanent Magnetic Ellipsoids for Maximum External Field in the Second Gaussian Principal Position [with Observing Point in Equatorial Plane of Ellipsoid: Calculations: Results in Graphical Form].—Neumann & Warmuth. (*E.N.T.*, Sept. 1936, Vol. 13, No. 9, pp. 295–309.)

377. THE INDUCTANCE OF IRON-CORED COILS HAVING AN AIR GAP.—Partridge. (*See* 310.)

378. THE EFFECT OF THE JOINTS IN THE PLATES OF A LAMINATED IRON CORE ON THE D.C. AMPERE-TURNS REQUIRED FOR ITS MAGNETISATION.—Phear & Mallock. (*Journ. I.E.E.*, Nov. 1936, Vol. 79, No. 479, pp. 560–564.)

379. HIGH-PERMEABILITY "FURUKAWA MAGNETIC ALLOY."—Furukawa Elec. Company. (*Nippon Elec. Comm. Engineering*, Sept. 1936, No. 4, pp. 315–321 : in English.)

380. THE OXIDE MAGNET OF KATO & TAKEI [Note on Tests : Remanence Values too Small for Useful Technical Applications].—Jellinghaus. (*Hochf:tech. u. Elek:akus.*, Aug. 1936, Vol. 48, No. 2, pp. 58–59.) For reference to this magnet *see* Abstracts, 1933, p. 579 (Kato & Takei) and 740 of 1936 (Kussmann) : *also* 1608 of 1936.

381. REMARKS ON THE MEASUREMENT OF PERMEABILITY BY MEANS OF THE SKIN EFFECT [Correction of Error in Hinze's Paper : Consideration of Magnetic After-Effects].—Becker. (*Ann. der Physik*, Series 5, No. 2, Vol. 27, 1936, pp. 123–128.) For Hinze's paper *see* 1934 Abstracts, p. 261.

382. MAGNETIC AFTER-EFFECTS (SUMMARISING REPORT).—Kindler & Thoma. (*Arch. f. Elektrot.*, 14th Aug. 1936, Vol. 30, No. 8, pp. 514–527.)

383. THE MAGNETIC BEHAVIOUR OF NICKEL AT TEMPERATURES UP TO THE CURIE POINT [Frequency Variation].—Schnabl. (*Ann. der Physik*, Series 5, No. 2, Vol. 27, 1936, pp. 169–185.)

384. A SCALE OF EIGHT IMPULSE COUNTER [using Argon-Filled Tubes, free from Temperature Dependence of Mercury-Filled Thyratrons, and with Deionisation Time below 5 Microseconds].—Shepherd & Haxby. (*Review Scient. Instr.*, Nov. 1936, Vol. 7, No. 11, pp. 425–426.)

385. A NEW AMPLIFIER FOR POINT COUNTERS AND COUNTING VALVES [Circuit with Retroaction extends Time Scale of Impulse until Counting Mechanism acts].—Schmitz. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 17, 1936, pp. 323–324.)

386. A SIMPLE SPARK-RECORDING APPARATUS [giving Permanent Records on Cheap Paper].—Dock. (*Journ. Scient. Instr.*, Nov. 1936, Vol. 13, No. 11, p. 370.)

387. A HIGH-SPEED CRYSTAL INK-WRITER [" Crystograph " Oscillograph using Movement of " Bimorth " Rochelle-Salt Crystal with Amplifying Lever].—Offner & Gerard. (*Science*, 28th Aug. 1936, Vol. 84, pp. 209–210.)

388. SUPERSONIC STROBOSCOPES.—Hiedemann & Hoesch. (*See* 189.)

389. A REVERSING GEAR AND ITS USES [*e.g.* as General Utility Recorder in connection with Photocells, Extensometers, etc.).—Balls. (*Journ. Scient. Instr.*, Oct. 1936, Vol. 13, No. 10, pp. 318–322.)

390. AN ELECTRIC MOTOR FOR RADIOMETEOROGRAPHS [to replace Clockwork : Weight 100 gms : 8 mA at 4.5 V].—Curtis & Astin. (*Review Scient. Instr.*, Sept. 1936, Vol. 7, No. 9, pp. 358–359.)

391. AN AUTOMATIC CURVE FOLLOWER [*e.g.* for cutting Cams or Templates : Servo Mechanism].—Hazen & others. (*Review Scient. Instr.*, Sept. 1936, Vol. 7, No. 9, pp. 353–357.)

392. A THYRATRON VOLTAGE CONTROL [for High-Precision High-Voltage Supply].—Burbank. (*Review Scient. Instr.*, Nov. 1936, Vol. 7, No. 11, pp. 427–429.)

393. ON THE PROBLEM OF FILAMENT-CIRCUIT SUPPLY IN RADIO INSTALLATIONS [Distorting Effects avoided by Unipolar Generators].—A. I. Joffe. (*Izvestiya Elektroprom. Slab. Toka*, No. 8/9, 1936, pp. 31–36.)

Author's summary :—" It is shown that the distorting effects arising when using a.c. supply or d.c. generators for filament heating are completely eliminated by the use of unipolar generators. Brief calculations of e.m.f. show that unipolar generators can find application in radio as sources of filament supply in place of accumulator batteries." A 10 kw generator giving 272 A is calculated.

394. THE EFFICIENCY OF GLOW-DISCHARGE TUBES AS VOLTAGE STABILISERS.—Hinzpeter. (*Hochf:tech. u. Elek:akus.*, Aug. 1936, Vol. 48, No. 2, pp. 56–57.)

The efficiency of a glow discharge tube in a stabilising circuit (Fig. 1) is calculated (§ II) and found to depend on the ratio of d.c. to a.c. impedance of the tube ; this ratio is named the *efficiency measure* [" Wirkmass "] and shown in Fig. 2. There is an optimum current strength for every experimental arrangement. A practical example is given ; the characterisation of a stabiliser by its running voltage and current, and a.c. impedance at the optimum working point, is proposed.

395. D.C. AND A.C. ION-CONVECTION GENERATORS.—Babat. (*Tech. Phys. of USSR*, No. 9, Vol. 3, 1936, pp. 786–802 : in English.)

It is well known that the overall efficiency of the usual processes for generating electrical energy from fuels is very low and that the greatest loss occurs at the intermediate step when heat energy is converted into mechanical movement. To eliminate this loss the author proposes a method (Russian Pats. 175 562, 175 979 & 181 794) which consists essentially in passing a stream of mercury vapour through a nozzle, across which an electric arc is maintained, and directing this stream on an insulated body (vapour condenser). The particles of the vapour in passing through the highly ionised space become positively charged, and on reaching the condenser raise its potential. An experimental model utilising this principle was built, and currents up to 50 MA at 100 V were obtained from it. General theoretical considerations underlying the design of such generators are discussed and a method is indicated for using these as a.c. generators. In conclusion it is shown that the thermal efficiency of the ion-convection generators is high and that their electrical efficiency is higher than that of ordinary electrical machines.

STATIONS, DESIGN AND OPERATION

396. BROADCASTING WITH CARRIER AND ONE SIDEBAND.—Siforov. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1936, pp. 1–12.)

Author's summary :—The analysis of the radiotelephone transmission system with carrier and one sideband is given. The expediency of its application to broadcasting is considered. The effect of distortions and interferences, when using up-to-date receivers, is considered. It is shown that in this case the ratio of signal intensity to interference, on changing from the usual system to the single-sideband transmission, is reduced 2.7 times. Methods are given for reducing distortion and interference when receiving single-sideband transmission, based on the decrease of modulation in the receiver. It is shown that by the use of this method the selectivity of the receiver is greatly increased. The problem of the modulation and interference effect on the synchronous channel of the receiver is investigated : it is shown that synchronisation will be stable even when the modulation exceeds 100%. The tendencies of further scientific research work on single-sideband broadcasting are described.

397. POSSIBILITY OF SIMULTANEOUS TRANSMISSION AND RECEPTION BY USE OF THE PERSISTENCE OF SENSATION OF SPEECH, *and* SIMULTANEOUS TRANSMISSION AND RECEPTION OF RADIO WAVES.—Marro : Antoun & Minaw. (*See* 181/182.)

398. PROGRESS IN BROADCASTING [in South Africa]. —Hilarius. (*S. African Engineering*, Oct. 1936, Vol. 47, No. 10, p. 271 : summary of paper.)

399. EDITORIAL ON THE FUTURE OF BROADCASTING IN INDIA, *and* ENGINEERING ORGANISATION OF NATION-WIDE BROADCASTING IN INDIA AND DEVELOPMENT OF INDIAN RADIO INDUSTRY.—Sreenivasan. (*Electrotechnics*, Bangalore, April, 1936, pp. 7–11 : pp. 23–46.)

400. BROADCASTING IN TASMANIA.—Jebb. (*Electrotechnics*, Bangalore, April, 1936, No. 9, pp. 89–95.)

401. THE VILLEJUST AND CAMPHIN BROADCASTING STATIONS [Paris-P.T.T. & Lille-P.T.T. : with Outphasing Modulation System].—Chireix. (*L'Onde Élec.*, Oct. 1936, Vol. 15, No. 178, pp. 598–616.)

402. NEW SHORT-WAVE REGULATIONS IN U.S.A.—Bullock. (*World-Radio*, 13th Nov. 1936, Vol. 23, p. 13.)

403. A PLANNED USE OF THE U.S.A. AMATEUR BANDS : EDITORIAL.—(*QST*, Oct. 1936, Vol. 20, No. 10, pp. 9–10.)

404. TEMPORARY ULTRA-SHORT-WAVE WIRELESS TELEGRAPH INSTALLATIONS AT TATEYAMA & TOYAMA [Fool-Proof and Portable Equipment for Communication over 38.5 km in Mountainous District : 5.5 Watts in Aerial]. —Yoshimi & Kishida. (*Nippon Elec. Comm. Engineering*, Sept. 1936, No. 4, pp. 365–366 : summary only, in English.)

405. RADIO-TELEPHONY ON 68 CENTIMETRE WAVES WITH PARABOLIC REFLECTORS.—Morita. (*Nippon Elec. Comm. Engineering*, Sept. 1936, No. 4, pp. 332–346 : in English.) *See* 2866 of 1936.

406. AMERICAN POLICE WIRELESS.—(*Wireless World*, 16th Oct. 1936, Vol. 39, pp. 397–398.)

407. THE ILLINOIS STATE POLICE-RADIO SYSTEM.— (*Comm. & Broadcast Eng.*, Sept. 1936, Vol. 3, No. 9, pp. 8–9 and 19.) For receiving equipment *see* 97, above.

408. CENTRAL EMITTING STATIONS OF THE GERMAN NATIONAL AIR SAFETY SERVICE [Construction Principles].—Zetzmann. (*Draht u. Aether*, Vol. 6, 1936, p. 60 : abstract only in *E.T.Z.*, 22nd Oct. 1936, Vol. 57, No. 43, p. 1243.)

409. THE WIRELESS EQUIPMENT OF THE AIRCRAFT DEPOT SHIP "OSTMARK."—(*Funktech. Monatshefte*, Oct. 1936, No. 10, pp. 395–396.) *See* also 3637 of 1936.

410. "AIRADIOS" [New Facilities for Air-Liner Passengers].—(*Wireless World*, 13th Nov. 1936, Vol. 39, pp. 505–506.)

GENERAL PHYSICAL ARTICLES

411. THE ELECTROMAGNETIC FIELD DUE TO A UNIFORMLY AND RIGIDLY ELECTRIFIED SPHERE IN SPINLESS ACCELERATED MOTION AND ITS MECHANICAL REACTION ON THE SPHERE.—Schott. (*Proc. Roy. Soc.*, Series A, 1st Sept. 1936, Vol. 156, No. 889, pp. 471–486 : 487–503.)

412. THE STRUCTURE OF ATOMIC NUCLEI [Theory of Interaction of Electromagnetic Whirls].—Japolsky : Podolsky. (*Phil. Mag.*, Oct. 1936, Series 7, Vol. 22, No. 148, pp. 537–581.) For criticism by Podolsky, and a reply, see *ibid.*, Nov. 1936, Supp. No. 150, pp. 998–1004 : for previous work *see* 810 of 1936.

413. ELECTROSTATIC ENERGY AS THE MUTUAL ENERGY OF VIBRATING PARTICLES.—Jones. (*Phil. Mag.*, Nov. 1936, Series 7, Vol. 22, Supp. No. 150, pp. 921–938.)

414. THE MASS OF THE "PRIMARY" PHOTON.— Laboccetta. (*La Ricerca Scient.*, 15th/31st Aug. 1936, 7th Year, Vol. 2, No. 3/4, pp. 207–209.)

415. TESTS OF THE VALIDITY OF X-RAY CRYSTAL METHODS OF DETERMINING *e*.—Du Mond & Bollman. (*Phys. Review*, 15th Sept. 1936, Series 2, Vol. 50, No. 6, pp. 524–537.)

416. VISCOSITY OF AIR AND ELECTRONIC CHARGE.— Majumdar & Vajifdar. (*Current Science*, Bangalore, Sept. 1936, Vol. 5, No. 3, p. 133.)

417. On the Oscillatory Movement of the Electron according to Dirac's Theory [and the Origin of the "Zitterbewegung" ("Quiver" Component)].—Wataghin. (*La Ricerca Scient.*, 15th/30th Sept. 1936, 7th Year, Vol. 2, No. 5/6, pp. 333–334.) *See* also *ibid.*, p. 341.

418. Fundamental Physical Constants [Estimates of Numerical Values deduced from Eddington's Theories].—Bond. (*Phil. Mag.*, Oct. 1936, Series 7, Vol. 22, No. 148, pp. 624–632.)

419. The Planck Quantum resolved into Its Elements, and a New Significance of the Eddington Number.—Laboccetta. (*La Ricerca Scient.*, 15th/31st Aug. 1936, 7th Year, Vol. 2, No. 3/4, pp. 212–215.)

420. "The Quantum Theory of Radiation" [Book Review].—Heitler. (*Review Scient. Instr.*, Oct. 1936, Vol. 7, No. 10, p. 370.)

421. On the Quantisation of a Theory arising from a Variational Principle for Multiple Integrals with Application to Born's Electrodynamics.—Weiss. (*Proc. Roy. Soc.*, Series A, 1st Aug. 1936, Vol. 156, No. 887, pp. 192–220.)

MISCELLANEOUS

422. The Practical Application of the Symbolical [Operational] Method for Solving Transient Phenomena [with Some New Operational Relations and Examples of Their Use].—Hak. (*Arch. f. Ekektrot.*, 15th Oct. 1936, Vol. 30, No. 10, pp. 671–677.)

423. Transient Induced Voltages in a Single Earthed Cable of Arbitrary Form [Calculations].—Buchholz. (*Arch. f. Elektrot.*, 15th Oct. 1936, Vol. 30, No. 10, pp. 637–651.)

424. The Numerical Summation of Slowly Convergent Series of Positive Terms.—Bickley & Miller. (*Phil. Mag.*, Nov. 1936, Series 7, Vol. 22, No. 149, pp. 754–767.)

425. A Note on the Synthesis of Fourier Series [Method of Sorting Strips].—Patterson. (*Phil. Mag.*, Nov. 1936, Series 7, Vol. 22, No. 149, pp. 753–754.) *See* also Beevers & Lipson, 1934 Abstracts, p. 339 (also 3232 of 1936) and Robertson, 1328 of 1936.

426. The Problem of Comparing the Results of Two Experiments with Unequal Errors.—Fairfield Smith. (*Journ. of Council for Sci. & Indust. Res.*, Australia, Aug. 1936, Vol. 9, No. 3, pp. 211–212.)

427. Curves of Exponential Functions [Chart, with Some Uses].—(*Rad. Engineering*, Sept. 1936, Vol. 16, No. 9, p. 18.)

428. The 12th Annual German Congress of Physicists and Mathematicians in Salzbrunn, 13th–19th Sept. 1936 [with Summaries of Papers on Geometrical Electron-Optics, Television, Acoustics, etc.].—(*E.N.T.*, Oct. 1936, Vol. 13, No. 10, pp. 361–363.)

429. Note on Scientific Writing: the Excess Word: Impersonal Constructions and the Passive Voice: Mixed Figures of Speech.—Urbach. (*Science*, 30th Oct. 1936, Vol. 84, pp. 390–391.) With examples from actual papers. "In the tropical countries of the world": why *of the world?* "There has been a tendency on the part of writers of text books. . . .": why not "writers . . . have tended. . . ."?

430. Principles of Scientific Publication [Publication a Part of Research: Cost should be borne by Institution or Individual sponsoring the Work].—Hammett. (*Science*, 2nd Oct. 1936, Vol. 84, pp. 310–311.) Subscription costs could be cut; fewer papers would be written; papers would be better written and prepared; etc.

431. "Classification for Works on Pure and Applied Science in the Science Museum Library: 3rd Edition" [Book Review].—(*Journ. Television Soc.*, June, 1936, Series 2, Vol. 2, Part 5, p. 178.)

432. The Responsibility of Engineering [Open Letter from President Roosevelt: Reply by Dr. Compton].—(*Science*, 30th Oct. 1936, Vol. 84, pp. 393–394.)

433. Optical Telephony [4.5 km Range with White Light, about 3 km with Almost Invisible Red: Modulating Power 1.5 W, D.C. Filament Consumption 3 W].—Köhler. (*E.T.Z.*, 19th Nov. 1936, Vol. 57, No. 47, pp. 1354–1355: summary only.)

434. On Saturation Currents [in X-Ray Tubes] due to Suddenly Applied Heavy Loads.—I. E. Balygin. (*Journ. of Tech. Phys.* [in Russian], No. 6, Vol. 6, 1936, pp. 1056–1063.) It appears from experimental curves that no current saturation takes place in the tube even at voltages and currents of the order of 68 kv and 200 mA respectively.

435. The Petoscope: a New Principle in Photoelectric Applications [Detection of Distant Moving Objects and Inspection of Materials by Photoelectric Apparatus with Response proportional to Rate of Change of Unbalancing Effect.].—A. S. Fitzgerald. (*Journ. Franklin Inst.*, Sept. 1936, Vol. 222, No. 3, pp. 289–325.) *See* also 1639 of 1936.

436. The Chilowski Photo-Relay [depending on Recombination of Mixture of Chlorine and Hydrogen: Wide Field of Application].—Chilowski. (*Génie Civil.* 14th Nov. 1936, Vol. 109, p. 439.) The first actual application was to turn on motor-car side-lamps at night-fall.

Some Recent Patents

The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each. A selection of abstracts from patents issued in the U.S.A. is also included, and these bear a seven-figure serial number.

TRANSMISSION CIRCUITS AND APPARATUS

449 322.—Relaying, or altering the character of signals radiated from a main transmitter at an intermediate point of their final destination.

J. Robinson. Application date 19th December, 1934.

449 871.—Stabilising the frequency of a back-coupled oscillation-generator by means of an anti-reaction circuit.

L. H. Paddle. Application date 2nd January, 1935.

450 444.—Method of frequency-modulation, in which the frequency-changes occur only at the start or finish of every half-cycle.

H. A. Richardson. Application date 30th November, 1935.

RECEPTION CIRCUITS AND APPARATUS

449 240.—Method of wave-band switching based on the application of a variable magnetising-current to iron-cored tuning-coils.

L. L. de Kramolin. Convention dates (Germany) 23rd October and 10th November, 1933; *5th and 14th March,* 1934.

449 391.—Fine-tuning arrangement for wireless receivers in which automatic adjustment is secured by varying the input capacitance of a control valve.

R. E. Spencer. Application date 14th December, 1934.

450 247.—Amplifier-circuit using a high degree of back-coupling whilst avoiding undesirable self-oscillation.

Radio-Akt D. S. Loewe. Convention date (Germany) 13th December, 1933.

450 472.—A power-operated automatic station-selector or tuner for a wireless set.

W. J. Bowman. Convention date (Canada) 20th April, 1934.

2 030 120.—Super-regenerative receiver in which a screen grid valve, operated as a dynatron, is used to provide the quenching oscillations.

N. M. Rust and R. F. O'Neill (assignors to Radio Corporation of America).

2 030 987.—Method of regulating the feed-back voltage in a valve circuit without affecting the fixed gain.

A. Herckmans (assignor to American Telephone & Telegraph Co.).

VALVES AND THERMIONICS

450 940.—Cathode-ray tube with a pin-point cathode and focusing electrodes.

A. C. Cossor and L. H. Bedford. Application date 24th January, 1935.

451 358.—Method of accurately spacing and assembling the internal electrodes of a thermionic valve.

Marconi's W.T. Co. (assignees of D. Y. Smith). Convention date (U.S.A.) 2nd February, 1934.

451 724.—Cold-cathode valve of the electron-multiplier type used as a short-wave oscillator.

Farnsworth Television Inc. Convention date (U.S.A.) 5th July, 1934.

DIRECTIONAL WIRELESS

450 484.—Direction-finding system giving a sharply-defined effect on "maximum" signal strength.

Telefunken Co. Convention date (Germany) 27th January, 1934.

451 019.—Direction-finding aerial system of the Adcock type fitted with a potentiometer indicator.

Standard Telephones & Cables (assignees of Le Materiel Telephonique). Convention date (France) 20th November, 1934.

452 290.—Aerial system designed to give accurate directional results, uninfluenced by the state of polarisation of the received signals.

R. H. Barfield. Application date 19th February, 1935.

TELEVISION AND PHOTOTELEGRAPHY

449 205.—Television receivers for combined sound and picture programmes.

General Electric Co.; D. C. Epsley; and G. C. Marris. Application date 19th March, 1935.

449 245.—Arrangement of deflecting-electrodes in a cathode-ray television receiver.

Radio-Akt D. S. Loewe.

449 466.—Push-pull rectifier for eliminating the carrier wave when receiving television.

Radio-Akt D. S. Loewe. Convention date (Germany) 21st October, 1933.

449 743.—Saw-toothed oscillation-generator with synchronised control for a television receiver.

Hazeltine Corporation (assignees of H. M. Lewis). Convention date (U.S.A.) 9th February, 1935.

449 822.—Preventing parasitic disturbances in cathode-ray television receivers.

General Electric Co. and D. C. Epsley. Application date 18th March, 1935.

450 241.—Push-pull detectors for receiving television signals.

Radio-Akt D. S. Loewe. Convention date (Germany) 10th November, 1933.

450 263.—Circuit designed to receive broadcast signals on the normal wavelengths and television signals on the ultra-short wave-band.

G. V. Dowding. Application date 25th February, 1935.

450 986.—Time-base circuit for television receivers.

General Electric Co. and D. C. Epsley. Application date 8th March, 1935.

451 117.—Circuit giving a linear time-base "sweep" for use in television.

A. C. Cossor and L. H. Bedford. Application date 29th January, 1935.

2 029 395.—Scanning system in which the light from two or more glow-lamps is superposed on the viewing screen from different points on the scanning disc.

T. A. Smith (assignor to Radio Corporation of America).